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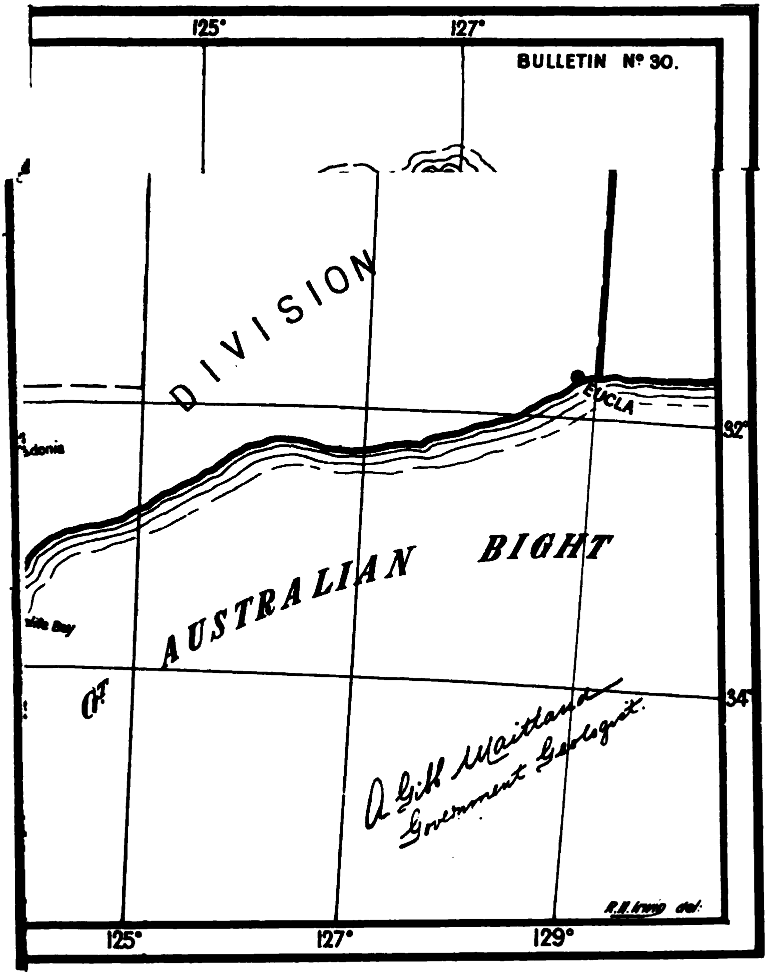

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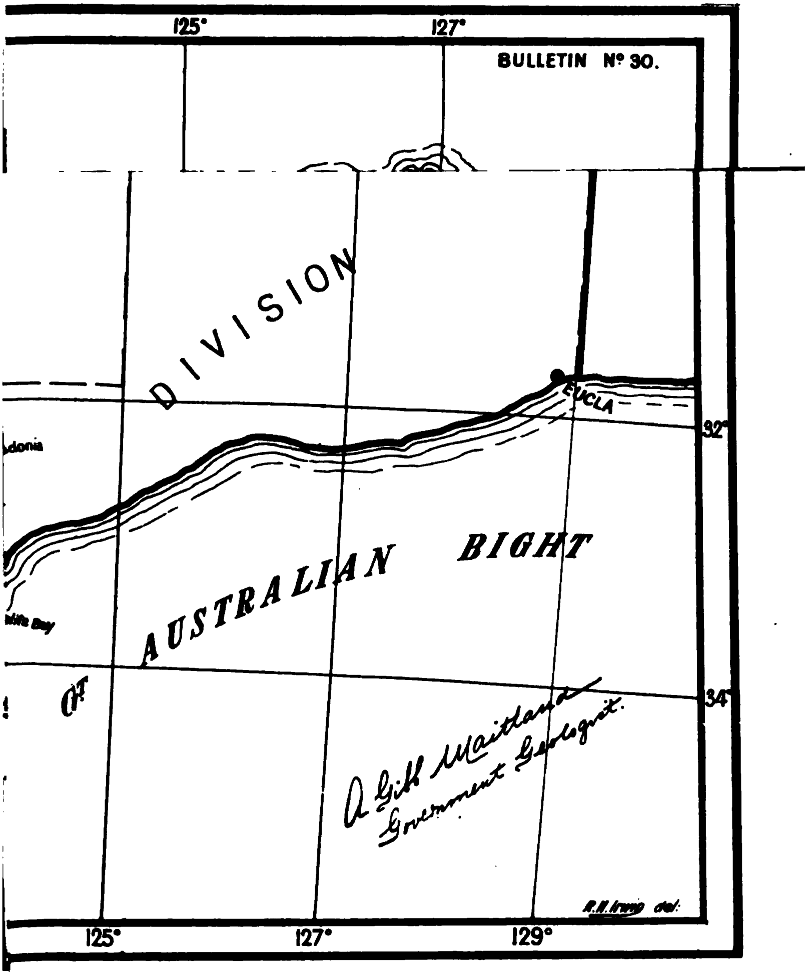

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1907.

WESTERN AUSTRALIA.

GEOLOGICAL SURVEY.

BULLETIN No. 30.

The Distribution and Occurrence of the Baser Metals

IN

WESTERN AUSTRALIA.

BY

EDWARD S. SIMPSON, B.E., F.C.S.,
Mineralogist and Assayer,

AND

CHAS. G. GIBSON, B.E.,
Assistant Geologist.

Issued under the authority of the Hon. H. Gregory, M.L.A.,
Minister for Mines.

WITH A MAP.

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PREFATORY NOTE.

Owing to the very great interest taken at the present time in what may be termed the commercial metals on account of their greatly increased value, the Hon. Minister for Mines issued instructions that this Bulletin should be compiled with the object of assisting prospectors and persons interested in the search for those other than gold.

Although collected from the most reliable sources, absolute accuracy cannot always be guaranteed, since portions of the information contained have necessarily been gathered from a variety of sources often only more or less authentic, whilst that relating to mines worked in the distant past, of which no record exists, may possibly be found to be like a story often told.

Unfortunately the districts in which these metals exist have not been recently examined by any member of this Staff, whilst the information obtained by the State Mining Engineer with regard to the Pilbara District is not yet available.

The figures given have been obtained from the official sources, but these unfortunately are far from perfect owing to the fact that many persons working these baser metals do not consider that it is compulsory for them to send in returns to the Mines Department of the ore raised, consequently parcels shown in the Customs returns have to be traced to their source, and likewise those treated at the Smelting Works.

The preparation of this Bulletin was entrusted to Mr. E. S. Simpson, B.E., Assayer and Mineralogist to this Department, and to Mr. C. G. Gibson, B.E., Assistant Geologist.

It is hoped that it will prove of service, and that by its means attention will be attracted to districts in which these metals either have or are reported to have been discovered ; and should this come to pass, the main object for which it was undertaken will have been accomplished.

HARRY P. WOODWARD,
Assistant Government Geologist.

Geological Survey Office,
Perth, 15th June, 1907.

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NOTES UPON THE OCCURRENCE OF VARIOUS ORES AND HOW THEY MAY BE RECOGNISED.

In writing a chapter upon the general occurrence of the various ores with the object of assisting the prospector, a task of considerable difficulty has been undertaken. for although the trained eye can detect certain little unexplainable points which lead the brain without mental effort to draw certain inferences, it is utterly impossible to impart this faculty by the means of a few sheets of printed matter, therefore an attempt will only be made to set down as concisely as possible those facts which are indispensable to the seeker of the baser metals.

The first point to be borne in mind by every prospector upon starting work in a new district is that he should not hurriedly condemn it because the occurrence of the ore is not identical with that in a district with which he is familiar. This is very apt to occur in this State where our metallic deposits, including gold, are frequently found to exist under totally different conditions to those prevailing in other parts of the world, therefore the intending prospector must not always expect to find either the same class of rocks or country here as that of which he may have had previous experience.

The metallic mineral deposits of Western Australia occur in two distinct series of rocks, the first being the crystalline, which includes the greenstones, granites, gneisses, and schists, and second the metamorphic or altered sedimentary, which consists of clay slates, crystalline limestones, quartzites, and conglomerates, both of which series are intersected by granite (generally pegmatite), diorite or porphyry dykes and quartz veins.

In the Kimberley district we find both of these formations, but in this case the schists are in reality highly altered sedimentary rocks, the change being due to the intrusion of large masses of granite. In the North-West district, the metamorphic rocks are largely developed but are traversed by numerous granite (pegmatite) dykes.

In the South-Western division, the rocks are for the most part gneissic granite with numerous intrusions of diorite and granite (pegmatite).

In the Central and Eastern divisions, the lodes as a rule occur in the greenstones (hornblende schists), but always in proximity to granitic and porphyritic intrusions.

Whilst upon the South Coast. although of a schistose character, certain points in the structure of the rocks lead one to the conclusion that they are partly of sedimentary origin and they are, like the northern, traversed by pegmatite dykes.

One very general feature of the mineral belts of this State is that the surface of the ground is strewn with fragments of quartz and ironstone.

COPPER.

The ores of this metal are found in greenstone and granite intersected by greenstone dykes as well as in schist or slate country, but also rarely in limestone; their presence is usually detected by the green staining of the rocks at the surface and the general association of quartz and ironstone (gossan). This green colour is due to the presence of malachite (green carbonate of copper) which is formed by the decomposition of the sulphide ore in the presence of water and air, which first forms near the surface a soluble sulphate of copper (bluestone) which is converted into the carbonate by meeting with carbonate of lime derived from the weathering of the enclosing rock. Capillary attraction and other causes lead to an enrichment of the deposit at and above the water level, it therefore follows that the true value of a copper lode cannot be determined until it has been explored below the water level.

There are many green minerals which, owing to their close resemblance to copper ore, may be mistaken for it, and, where little more than stains exist, it is impossible to discriminate between these by the weight, but if one of the following tests be employed, the point may be settled with certainty:—First, carbonate of copper is soft and soluble in acids with effervescence; second, if dissolved in vinegar and then ammonia is added slowly to the solution it becomes clouded and a bluish white precipitate is formed, which upon the addition of more ammonia dissolves again, giving a clear deep blue liquid ; and third, when no acid is available the presence of copper in ore can be determined by reducing it to a powder and mixing with common salt then sprinkling it upon a fire, when the characteristic green flame will appear although only a minute quantity be present.

The second and third of these tests apply to all classes of copper ore, but the first only to carbonates.

Below the green-stained lode cap, a liver-coloured ore is often met with; this consists of a mixture of red oxide of copper and iron with grains of green carbonate and black sulphide. This class of ore cuts with a bright shining streak, whilst the softer it is the higher is its quality.

The highest grade ore is usually found at or about the water l, where the partial alteration and concentration of the sulphides gives rise to a mixture of red and black oxides with black sulphide, bornite, fahl ore, and other minerals exceptionally rich in copper. Slugs or ragged plates of metallic copper are often met with in a more or less powdery mass of black decomposing sulphides at this level, whilst silver is usually present to a marked extent.

The sulphides which occur mostly below the water level consist of a golden-coloured ore, which is a mixture of copper and iron pyrites. All sulphides containing copper will cut with a knife, and are easily distinguished from iron pyrites, which is so hard that it will strike fire with a steel, whilst the ease with which copper sulphides will cut, or their softness, is a good indication of their quality.

Much of the value of copper ores is due to the gold and silver contained in them, so that assays for these metals should not be omitted whenever practicable.

TIN.

The presence of tin is usually denoted by small bright black or greyish stones of great weight for their size, which feature enables them to be easily separated from the sand and clay (with which they are usually associated) by means of washing with a dish or dryblowing. This ore is always found in close association with granite rocks, especially those which carry tourmaline, lithia mica, or tantalum ores.

Tin ore is usually met with in the alluvial wash of stream beds (when it is called stream tin), but in the North-West, where no concentration has taken place, owing to the flatness of the surface and the small rainfall, it is also found strewn over the surface of the plains and embedded in the shallow soil of gentle slopes.

These alluvial deposits are generally derived from the weathering of the stanniferous pegmatite dykes, which are coarse granites containing large crystals of felspar, mica (sometimes in large enough plates to be of commercial value), and ragged quartz, and sometimes also black six-sided crystals of tourmaline, the enclosing country rock in this State being generally crystalline and mostly granitic.

Stream tin is generally more or less rounded, having a bright polished surface, whilst the lode tin, when in crystals, has eight sides, and in form is like two four-sided pyramids joined base to base ; both of these forms may be coated with a thin ferruginous covering of a dull chocolate colour, but when broken the bright resin-like fracture so characteristic of tin oxide will be at once observed.

The principal characters by which tin ore may be recognised are its high specific gravity or weight, the brilliant lustre fracture, its streak or powder, which is of a grey or brownish-grey colour, and the fact that it is fused with the greatest difficulty alone, but yields a bead of metallic tin when treated with carbonate of soda or cyanide of potassium upon charcoal before the blowpipe, or in a crucible in a forge or furnace ; the metallic tin being easily distinguished from any other metal by the peculiar crackling sensation it produces when pressed between the teeth. Tin, in any form, is not magnetic, it will neither attract the needle of the compass nor can fragments be picked up by a magnet either before or after fusion.

It is easily distinguished from the majority of minerals by its weight, but it may be confused with any of the five following heavy minerals, particularly if in small fragments, when the difference in weight is not so readily appreciated :—

The first three, viz., magnetite, ilmenite (titanic iron ore), and rutile, although not nearly so heavy as tin, are often mistaken for it, but they may be distinguished as follows :—Magnetite by its magnetic properties and black streak or powder; ilmenite (black sand) gives a black streak and becomes magnetised after heating to redness with charcoal, and in the form of powder when washed in a dish runs, with a glittering appearance. If the finger is damped and dipped into the ordinary black sand it will adhere to it whilst tin will not. Rutile is more difficult to distinguish from the preceding, the most noticeable points being that it does not possess the brilliant fracture of tin ore, and it yields a reddish-brown powder : however, it will yield no tin with the blowpipe or by smelting.

In the case of wolfram and tantalite, whose weight is so similar to tin, this feature cannot be taken advantage of, but since wolfram fuses easily to a magnetic bead, this can be quickly determined ; whilst in the case of tantalite, a freshly fractured surface is much more stony looking than that of tin ore; but the non-production of a tin button after fusion with soda or cyanide is the only simple test that can be depended upon.

LEAD.

As a rule lead lodes give little or no evidence of their existence at the surface, for even where masses of galena outcrop, the ore is so coated with earthy oxides of iron that they appear like ironstone, and this erroneous impression will not be dispelled until the weight of a detached fragment is felt or a portion broken, when the brilliant silvery interior will be revealed.

Carbonate and phosphate ores also occur at the outcrop of lead lodes, but these, like the galena, are always so discoloured that their presence attracts no attention until, like that ore, the weight of a piece is felt, and this, when broken, will exhibit a white, grey, or ghtly tinted substance, often gossamy and easily cut with a knife.

Lead lodes occur in both the crystalline, metamorphic, and even sedimentary series, but for the most part in this State are associated either with greenstone or slate, although they sometimes occur with limestone and granite. The lode matter is generally quartz, with the exception of the limestone country, in which it is calcite, whilst the ore is usually associated with zinc blende, iron, and sometimes graphite or copper. All the ores of lead are easily reduced to the metallic state by the aid of the blowpipe ; specular iron ore is sometimes, however, taken for galena on account of its silvery metallic appearance, when no means of testing are at hand; however, this question is easily and simply settled if a small portion is reduced to a powder, when, if iron, it will be a reddish-brown, and if galena, a steel grey.

Antimony also resembles galena in that it is a soft silvery metallic-like mineral, but it is easily distinguished, as small splints of it will fuse easily in the flame of a candle.

Barite (heavy spar), scheelite, and even dolomite are sometimes taken for lead carbonate, but the two former are unaffected with acid, and the latter will only effervesce in hot concentrated acid, whilst lead effervesces freely in any dilute acid and yields metallic lead with the blowpipe on charcoal.

Lead ores usually carry more or less silver and gold, but except in the Ashburton District the lodes of this State, particularly in the Northampton District, have so far proved to be almost destitute of these precious metals, which, of course, very materially reduces their value ; as, however, there is always the possibility of their containing these metals in appreciable quantities it is advisable to have samples tested by an assayer, since the enhanced value due to their presence might make all the difference, particularly where heavy cartage has to be considered.

ZINC.

The ores of zinc have not so far been worked in this State, but they occur as associated minerals with both copper and lead, in which case they are, however, not an advantage, as they increase the difficulties of smelting. It is possible, however, that they may be found later on to exist in sufficient quantities to pay to work.

The most common ore of zinc is blende, which possesses a brilliant black sub-metallic lustre something like black lead, but the streak or powder is brown. If the blowpipe flame is played upon a small fragment, or a piece is raised to a bright red heat in a forge, it will burn, giving off dense white fumes and a bluish flame.

IRON.

Iron ore is generally distributed throughout all geological formations. At the present time it is of no commercial value as a source of iron in this State, but has been applied economically to one purpose, viz., in smelting lead and copper ores. The quality required for this purpose is a high class oxide containing very little silica (quartz), it is usually of a chocolate colour, but grinds into a red or brown ochre.

MANGANESE.

The ore of this metal occurs most generally as a dead black mineral, sometimes quite soft and sooty in appearance, soiling the hands, and, like iron, with which it is usually associated, it is widely distributed throughout this State, but so far has not been discovered in large enough bodies to be payable, except, possibly, in the Phillips River District.

TANTALITE AND WOLFRAM.

These are some of the heavy minerals which, in mode of occurrence, appearance, and physical characters closely resemble tin ore, with which they are often associated. As the determination of these minerals require a certain amount of knowledge and apparatus not usually available in the bush, it is advisable to forward samples to a qualified man to be tested.

Below is appended the scale of fees charged for works of this character undertaken by this Department, particular attention being directed to Section 7, under which this work is undertaken free of charge.

HARRY P. WOODWARD,
Assistant Government Geologist.

8/7/07.

GOVERNMENT ASSAYS.

Assays, Analyses, and Determinations of any Western Australian Ore or Rock will be made by the Assayer to the Geological Survey, ***when not unduly interfering with official work,*** subject to the following conditions :—

1. Each sample must weigh at least 6oz., but not more than 2lbs.

2. Each sample must be enclosed in a separate canvas bag or strong paper wrapper, with a slip of paper bearing the name and address of the sender, together with a private mark by which it may be readily identified.

3. The parcel must be forwarded *prepaid* to :—

The Mineralogist and Assayer,
Geological Survey Office,
Perth.

4. A letter must be sent at the same time to the same address, stating for what metals the samples are to be assayed, or containing other instructions, as the case may be.

(N.B.—It is always advisable to keep duplicate samples of those submitted.)

5. Before any assay is made, the prescribed fee must be paid to the Mineralogist and Assayer, or sufficient reasons, in accordance with Section 7 below, be furnished for having the samples treated free of cost.

6. The following fees will be charged :—

	£	s.	d.
(*a.*) Determination of a Rock or Mineral.. ..	0	10	6
(*b.*) Assay for Lead, Iron, or Manganese, each ..	0	10	6
(*c.*) Assay for Silver, Copper, or Tin, each ..	0	12	6
(*d.*) Assay for Gold or Zinc, each..	0	15	0
(*e.*) Dry Assay for Lead, Silver, and Gold ..	1	1	0
(*f.*) Assay for Antimony, Bismuth, Chromium, Cobalt, Mercury, or Nickel, each	1	11	6
(*g.*) Proximate Analysis and Calorific Valuation of Coal	1	11	6
(*h.*) Complete Chemical Analysis of any Mineral or Ore, according to number and nature of determinations, £2 12s. 6d. to	5	5	0
(*i.*) Other determinations, according to time spent, up to	2	12	6

A reduction of 20 per cent. on the above amounts will be made in favour of any person submitting in one parcel five or more samples for identical treatment.

7. With the object of encouraging *bona fide* prospecting, free assays will be made under the following circumstances :—

(*a.*) The sample must have been obtained from land within the State not held under lease for mining purposes.

(*b.*) The exact locality where the sample was found must be disclosed.

(*c.*) The sample must be of sufficient promise to warrant an assay being made at the expense of the State.

(*d.*) Free assays will not be made of samples showing free gold, or of tailings or other metallurgical products, or of umpire samples.

8. The Department reserves to itself the right of refusing to make any particular assay, and also the right of publishing at any time the results of an assay made at the public expense.

The Distribution and Occurrence of the Baser Metals in Western Australia.

BY

EDWARD S. SIMPSON, B.E., F.C.S.,
Mineralogist and Assayer,

AND

CHAS. G. GIBSON, B.E.,
Assistant Geologist.

INTRODUCTION.

In 1904 the total value of the minerals raised in the State was £8,623,587, of which £8,424,226 were credited to fine gold, £45,912 to fine silver, and only £84,574 to the baser metals, which, partly owing to low prices, and partly to the comparative ease with which gold could be obtained, were then practically neglected in Western Australia. During the last two years, however, a markedly increased demand has arisen for these metals and a correspondingly marked increase in prices has resulted. The result has been to stimulate the search for copper, tin, lead, etc., though not to an extent commensurate with the latent wealth in those metals which the State possesses. In order if possible to draw public attention to these little developed sources of wealth the authors were instructed to prepare immediately a short Bulletin which should include all the most important official information available with regard to the distribution and occurrence of these metals.

From the outset the authors found themselves faced with two great difficulties. First, the scantiness of official information, as for example, no reports whatever (other than statistics of output) are available with regard to one of our largest producers of base metal, viz., the Anaconda Copper Mine at Murrin Murrin.* Second, the fact that in view of recent developments, much of the information contained in official documents is now out of date. This has been remedied to a slight extent by inquiries instituted amongst various officials and private sources of a reliable nature. Still, however, many serious omissions doubtless occur in the following pages which were under the circumstances unavoidable.

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* Examination made subsequently.—H.P.W.

The statistics so essential to a brochure of this nature were found very difficult to compile for many reasons, of which the most important are:—

1. Previous to 1899 no statistics were kept of the production of the baser metals.
2. Since 1899 leaseholders have often failed to supply to the Mines Statist the complete figures of their output.
3. One and the same mine or piece of mineral ground has passed under so many aliases, being voided and re-pegged (not always with precisely the same boundaries), changing owners and being worked singly and in various groups. In the case of the Greenbushes alluvial tin deposits particularly, the changes of this description are like a complicated problem in permutations and combinations, and in consequence one year's statistics only have been included in the case of many tenements.

So far, however, as they go the statistics given are those of official authorities and are probably very close approximations to the truth, though undoubtedly on the low side.

EDWARD S. SIMPSON,
CHAS. G. GIBSON.

Perth, 12th June, 1907.

COPPER.

The following is a list of the principal commercial ores of copper, with their physical properties:—

(1.) *Native Copper* occurs usually in the upper or oxidised portion of lodes as irregular shaped fragments or masses of crystalline or arborescent form, generally coated with cuprite or malachite. Red; opaque; metallic. Soft, tough, malleable. Specific gravity when pure, 8 to 8.9.

(2.) *Cuprite* (Red Oxide of Copper), Cu_2O, occurs in the upper or oxidised portion of the lode and is the richest of the ores of copper. Contains 88.8 per cent. of copper. Bright or dark red; translucent to opaque; crystalline, massive, or granular. Soft, brittle. Sp. Gr. 5.9 to 6.1.

(3.) *Tenorite* (Melaconite or Black Oxide of Copper).—CuO. The second richest ore of copper. Usually occurs in a loose powder between the undecomposed sulphide ores and the oxidised ores above them; frequently mixed with more or less chalcocite (Cu_2S). Contains 80 per cent. of copper. Black; metallic or dull scaly, massive, or earthy, soft. Sp. Gr. 5.8 to 6.2.

(4.) *Malachite* (Green Carbonate of Copper).—$CuCO_3.Cu(OH)_2$. One of the most common of surface minerals in copper-bearing deposits; usually confined to the oxidised zone. Contains 57.4 per cent. of copper. Bright green; opaque; crystallised or more commonly massive, stalactitic, radially fibrous, or earthy; soft, brittle. Sp. Gr. 4.0.

(5.) *Azurite*. (Chessylite, Blue Carbonate of Copper).—$2CuCO_3.Cu(HO)_2$. Usually found associated with malachite in the oxidised portions of lodes. Contains 55.2 per cent. of copper. Azure blue; transparent to opaque; crystalline, massive, compact, or earthy; soft, brittle. Sp. Gr. 3.8.

(6.) *Chalcocite* (Copper Glance, Vitreous Copper ore, Grey Sulphide of Copper).—Sulphide of copper. Cu_2S. Contains 79.8 per cent. of copper. Black, metallic, opaque, crystallised or granular, rarely massive; soft, brittle. Sp. Gr. 5.7.

(7.) *Bornite* (Erubescite, Peacock ore, Variegated copper ore). —Sulphide of copper and iron, $3Cu_2S.Fe_2S_3$. An important ore of copper containing 55.5 per cent. of copper and 16.4 per cent.

of iron. Colour of fresh fracture red brown, soon becoming iridescent from tarnish; opaque; crystallised, massive, granular, or compact; soft, brittle. Sp. Gr. 5 to 5.4.

(8.) *Chalcopyrite* (Copper Pyrites, Yellow Sulphide of Copper).—Sulphide of copper and iron, $Cu_2S.Fe_2S_3$. One of the commonest and most important of the ores of copper and is almost invariably found in all lodes below water level. It is to the decomposition of this ore that nearly all copper-bearing minerals found in the oxidised portions of lodes owe their origin. Is rarely found pure, being generally associated with more or less iron pyrites. Contains 34.5 per cent. of copper and 30.5 per cent. of iron. Brass yellow, often iridescent ; metallic, opaque ; crystallised or massive ; soft, brittle. Sp. Gr. 4.2.

(9.) *Tetrahedrite* (Fahl ore).—Sulphide of copper and antimony with variable amounts of arsenic, bismuth, iron, zinc, lead, silver, or mercury. Contains from 15 to 44 per cent. of copper. Grey to black; metallic, opaque; crystallised or massive, compact or granular; soft, brittle. Sp. Gr. 4.7.

Early History of the Discoveries of Copper in Western Australia.

The history of mining in the State of Western Australia begins with the discovery in 1842 of the Wanerenooka copper lode at Northampton. The discoverer, Thomas Mason, a shepherd, sold his discovery to a company which shortly afterwards opened up the mine. Several other lodes of copper and lead ores were also located about this time, and before the end of 1845 the first consignment of copper ore had left the State to be smelted in Wales. With more or less interruption ore has been raised at Northampton ever since.

In the year 1848 copper ore was discovered on the Murchison, and specimens were received in Perth in August of that year, and on being sent to Adelaide for assay were found to contain not only copper and lead but also " traces of gold," and one piece the assayer certified as being richer in silver than any ore found up to that time in South Australia. The Government despatched a party to the scene of the discovery under the leadership of Mr. A. Gregory, and the property was opened up in the following year and known as the Geraldine.

In 1849 the Western Australian Mining Company (organised in the first instance in 1847 to prospect for coal) carried on prospecting operations near Kelmscott, as indications of copper were said to have been found there, but with no result; and the company was dissolved early in 1850.

A little later copper was discovered and worked at Arrino (Yandanooka district), but never to any great extent.

In 1872 rich copper and lead deposits were found near Roebourne, and in the following year 60 tons of ore were exported from Cossack.

In 1872 a copper mine known as Sherard's mine was opened up at East Mt. Barren, on the Phillips River, and in the same year a little work was done on some deposits at Mt. Scratch (Irwin district), and at Cook's Station, Arrino.

In 1883 Mr. Hardman, then Government Geologist, reported the occurrence of copper at several localities in the Kimberley district.

For some years after this, owing to the excitement caused by the almost daily finds of new goldfields, practically no attention was paid to the presence of other metals, though doubtless many indications of such were noticed in the search for the noble metal; most of the previously worked mines even were temporarily abandoned.

In 1890 a very rich copper lode was opened up about 50 miles east of Roebourne.

In 1898 the Anaconda lode at Murrin Murrin was discovered, and ore raised in the following year.

Copper had previously been known to occur in the Phillips River district, and a mine had been opened and worked to a certain extent near Middle Mt. Barren, but it was not until 1899 that the more extensive deposits at Ravensthorpe and Kundip were first exploited. In the same year lodes of argentiferous copper ore were located at Uaroo (Ashburton district). Other deposits at Day Dawn, Gabanintha, etc., are of recent discovery.

The following is a list of the localities from which copper ore is reported to have been raised:—

Kimberley—Napier Range (Mondooma), Mt. Nellie.

North-West—Balla-Balla, Croydon, Egina, Roebourne, Whim Creek, Red Hill, Uaroo, Westons, Metawandy Creek, Mt. Stuart, Day Dawn, Gabanintha, Twin Peaks, Yalgoo.

Central—Murrin Murrin, Goongarrie, Broad Arrow.

South-West—Geraldine, Northampton, Narra Tarra, Oakagee, Mt. Misery, Arrino, Jerramongup, Kundip, Mt. Desmond, Middle Mt. Barren, Ravensthorpe, West River.

The following is a list of other localities from which copper has been reported, with the nature of the occurrence :—

Division.	Centre.	Nature of occurrence.
Kimberley	Ivanhoe Station	Massive carbonates of copper and lead
	Geikie Range	Strings of carbonate ore in limestone
	Hall's Creek ...	Carbonate ore
	Devil's Pass ...	do.
	Margaret River	Carbonates in quartz reef
	Mt. Dockrell ...	
	Mt. Pierre ...	Carbonate ore in limestone
	Mueller Range	
	Panton River	Carbonate ore
	Ruby Creek ...	
	Oscar Range ...	Strings of carbonate ore in limestone
North-West	Gorge Creek ...	Carbonates in quartz
	Hong Kong ...	Massive sulphide ore
	Maitland River	
	Marble Bar ...	
	Nichol River...	Carbonate ore
	20-Mile Sandy	
	Tambourah ...	Massive carbonate ore
	Warrawoona...	Carbonate ore
	Wyman's ...	do.
	Yandicoogina	Carbonate ore in quartz gangue.*
	Belele Station	Carbonate ore in quartz
	Horseshoe ...	Carbonates in quartz reef
	Mt. Gould ...	do. do.
	Munarra Gully	Bunches of carbonate ore in quartz reef
	Rothsay ...	Carbonate ore in siliceous lode stuff
Central ...	Boorara ...	Carbonate ore
	Boulder ...	Fahl ore in auriferous lode stuff
	Coolgardie ...	Carbonates in quartz reefs
	Erlistoun ...	Carbonates in quartz reef
	Kalgoorlie ...	Carbonates and sulphides in quartz reefs
	Knutsford ...	Carbonates in auriferous lodes
	Leonora ...	Carbonates in quartz reef
	Mt. Ida ...	Carbonates and native copper in quartz reef
	Mulline ...	Carbonates in quartz reefs
	Sir Samuel ...	do. do.
South-West	Greenmount ...	Native copper in greenstone (diabase) dyke
	Serpentine ...	Copper pyrites in quartz reef
	Wongan Hills	Carbonates in quartz reefs
	Bremer Bay ...	Carbonate ore in siliceous lode material
Eucla ...	Dundas ...	Carbonates in quartz reef.

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* Assays of Copper ore from Yandicoogina :—

No. 1—Malachite and cerussite in quartz gangue ; Copper, 1·10 per cent. ; Lead, 2·39 per cent. ; Gold, 13 grains per ton : Silver, 6·1 ounces per ton.

No. 2—Oxidised (carbonate) ore ; Copper, 12·81 per cent. ; Lead, 2·57 per cent. ; Gold, 13 grains per ton ; Silver, 21·1 ounces per ton.

General description of the principal districts in which Copper has been worked, with a brief description of the deposits.

KIMBERLEY.

NAPIER RANGE.*

At the north end of the Napier Range the crystalline limestone of the Ranges is replaced by mica schist with diorite dykes striking nearly east and west, and alongside one of these dykes a copper-stained ferruginous reef has been traced on the surface for about 300 yards. Costeens at different places along this reef proved the lode to be small and to carry very little copper, and although a few tons of fair grade ore might be picked, the negative character of the developments are such as to prove that the deposit is of no value.

MOUNT NELLIE.*

The belt of country in which these deposits occur is schist and slate intersected by quartz reefs and diorite dykes, and extends north-westerly from Mondooma on the Robinson River to Mt. Nellie. In this belt of schists are a series of dyke-like mineralized quartzose ridges containing quartz veins often much copper stained, and often of considerable size and length ; these veins in addition to being much stained often contain copper either in veins, bunches, or disseminated through the quartz itself. On Grant's Reward Reef the lode mass rises in the form of a razor-backed ridge to a height of about 100ft., having a width at the base of about 50ft., while it can be traced for over one-and-a-quarter miles in length. In this body there are three distinct quartz veins or chutes, the central one of which is the largest, being seven chains in length, and varying from two to seventeen feet in thickness on the surface. The ore is mostly green carbonate and red oxide, and is met with at one or two points in the form of small veins or bunches of high grade ore, but it generally occurs intimately mixed with quartz, when it varies from low grade siliceous ore to stained quartz.

There are a number of similar lode masses in the locality, but these possess no further indications than copper stains.

NORTH-WEST.

WHIM CREEK.

Whim Well Copper Mine (Freehold—100 acres). This property was first opened up in 1890, and was worked with highly satisfactory results for some years, when the low price of copper caused it to be shut down ; during the past year, however, work has again been started on it.

The country in which the deposit is situated is hilly, and consists of a somewhat weathered talcose schist, the foliation of which runs a little north of west and south of east. The lode outcrops along the top of a ridge of three hills whose northern slope is such that the lode in places actually forms the face of the hills ; its general trend is about west-north-west and east-south-east, its dip being to the northward, and it is traceable on the surface for about half a mile.

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*Geological Survey of Western Australia, Annual Report, 1906. H. P. Woodward, Recent Mineral discoveries in West Kimberley.

The general thickness of the lode throughout the principal workings has been from six to twelve feet, and it consists of a soft light-coloured aluminous rock, which, near the surface, is highly impregnated—principally on the hanging wall side—with copper, occurring chiefly as veins and masses of blue and green carbonates, often of considerable size.

The main workings are on the side of the middle hill, and the lode has here been worked over an area six to eight chains square by means of a number of open cuts, quarries, and tunnels of a most irregular nature, and some very rich pockets of ore have been taken out. Some chains further west is a second set of similar workings, and also a couple of long tunnels, in one of which the lode appears as a light-coloured foliated rock, closely resembling the surrounding country, and seamed with small veins and gashes of carbonate ore.

Up to the end of 1906, 9,097.00 tons of ore are reported as having been produced from the property, at a value of £84,987, the ore averaging about 20 per cent.

Supplementary Note by the State Mining Engineer, Mr. A. Montgomery, M.A., etc.

There are two principal copper mines in the Whim Creek District, both now held by the Whim Well Copper Mines, Ltd., the "Whim Well" mine being 13½ miles south from the port of Balla Balla, and the "Mons Cupri" about three miles S.S.W. from the "Whim Well." The Whim Well deposit is a very flat-lying lode, or possibly bedded deposit, lying conformably with the bedding of the enclosing slate country. This is very irregular, the somewhat flat-lying strata having been subjected to crumpling movements which have caused great variations in the strike and dip of the beds. So far as yet seen the ore deposits partake of the same bends and crumplings as the enclosing strata, and are therefore also of very irregular shape. It outcrops on the top and north side of a small range of hills running more or less east and west, and dips northerly almost parallel with the slope of the hill, and has been laid bare on the sides of the hill at several points by removal of the superincumbent strata by denudation. As the hill slopes flatten out towards the foot the ore-body is under more cover, being found in two shafts at a depth of about 70ft. The outcrop is traceable for about 50 chains in length, and has been cut into by a number of open cuttings and workings from shallow tunnels. The ore consists of carbonates and oxides of copper, usually much mixed with oxide of iron, and copper glance, in a gangue of kaolin, quartz, and brown iron ore. The country in the vicinity of the ore-deposit often contains a good deal of carbonate of copper. The ore-body is irregular in thickness, being from 2ft. to 30ft. wide, but would probably average at least 6ft. in thickness in the faces at present exposed. Some fine and large bunches of rich ore have been obtained.

The official returns show the following export of ore :—

Year.	Tons of Ore.	Value.
Previous to 1899	6,638·00	£49,785
1899	1,405·00	20,196
1900	Nil	Nil
1901	1,054·00	15,006
1902 to 1906 ...	Nil	Nil
To end of May, 1907 ...	976·00	25,340
TOTAL	10,073·00	£110,327

The grade of ore shipped in 1901 and 1907 was about 26 per cent. copper, that previously exported varying from 22 to 40 per cent. According to a recent estimate made for the Company there are about 200,000 tons of payable ore available above the water level. The amount of second-class ore, of 8 to 10 per cent. copper, now broken on the dumps, is estimated roughly at 10,000 to 12,000 tons, and there is also a large amount of lower grade material much of which will be workable by local smelting or lixiviation treatment as the mine progresses. The mine's record of production is very good, and as the deposit is strong and of good value at the bottom of the shafts there is every reason to expect a payable output to be maintained. The Company are about to build a light railway from Balla Balla, and have the establishment of local smelting works under consideration.

The "Mons Cupri" deposit is of irregular nature, no defined ore-body having been discovered. The ore, which is mostly carbonates and oxides of copper, is found in veins and bunches, and facing crevices in the country rock forming the top of the Mons Cupri hill, and evidently results from precipitation from copper-bearing solutions traversing the country. The amount of copper-bearing rock is very large, but the value in copper is poor on the whole. A small smelting plant is on this mine, but has done very little work.

The official records show the following production :—

Year.	Tons of Ore.	Value.
		£
1899—M.L. 5, Balla Balla Copper Mine ...	356·00	2,408
M.L. 12, Mons Cupri	369·00	2,537
1900—M.L. 34,* (5, 12) Balla Balla Copper Mine	1,198·00	6,493
1901— Do. do.	86·00	598
Total to date (31-5-07)	2,009 00	12,036

* M.L. 34 transferred to Whim Well Copper Mines, Ltd., from 9-4-07.

A. MONTGOMERY,
State Mining Engineer.

18th July, 1907.

MONS CUPRI.

Balla Balla Copper Mines, Ltd., 34-5, 12.—Situated about four miles from Whim Creek, and in similar class of country. A good deal of work has been done, principally open-cutting and tunnelling. Several shafts have been sunk, but not to any great depth. The lode strikes about north-west and south-east, and dips to the northward ; it is highly siliceous, somewhat resembling a fine-grained. quartzite. The ore is mostly carbonate, and is well disseminated through the lode, though a few small veins of good ore occur near the surface; taken in bulk the ore will require considerable concentration. It has been estimated that there are about 120,000 tons of ore visible, made up by a block 600ft. in length, 18ft. in thickness, and 150ft. in depth, of an estimated value of from three to four per cent. ; no sulphide ore has so far been met with. The company have a 40-ton blast furnace on their property, and the result of several small runs have recently shown the ore so far to average from five to six per cent. copper.

From the official reports it would appear that these leases have, up to the end of 1906, produced 2,009.00 tons of ore, valued at £12,036 ; the average contents being 10 per cent. of copper.

Other leases in the Whim Creek district which have produced copper ore, and about which no particulars are available, are :—

(1.) Rudall's Lease (10), which has produced 20.00 tons of ore, valued at £150 (total).

(2.) The Stranger, which has produced 10.00 tons of ore, worth £100 (total).

EGINA.

Egina Copper Mine, (3), 40 miles east of Whim Creek. Lode said to be from 3ft. to 14ft. in width, but very patchy. Some very good ore taken out in its early days. Has produced 530 tons of ore, valued at £6,571.

CROYDON.

National Copper Mine (originally the Evelyn Copper Mine, 31).—In 1900 five shafts had been sunk on this property to an average depth of 60ft. The ore is said to have been very refractory, but of good grade. A small shipment sent away about the end of 1900 went from 20 to 25 per cent. copper. The total production to the end of 1906 was 453 tons of ore, worth £5,593.

Croydon King Copper Mine, 26.—No particulars. Ore raised, 40 tons, valued at £595.

Boston Copper Mine.—No particulars.

ROEBOURNE.

Carlow Castle, 14 (formerly known as the Six Mile).—No particulars. Has produced 133 tons of ore, worth £1,991. Recently taken up again.

Five Mile Copper Mine, five miles south-west of Roebourne. Worked in 1898 ; no particulars.

Federation, 42, has produced 26.00 tons of ore, valued at £468.

Glenderry, 49, has produced 22.00 tons of ore, valued at £287. The ore having had an average value of about 20 per cent. of copper.

Lily Blanche Copper Mine.—Ore said to be worth 20 to 25 per cent. copper is now being raised from this property, the lode being stated to be seven feet in width.

BALLA BALLA.

In 1897 several mineral leases were taken up here ; assays gave from 15 to 35 per cent. copper, with traces of gold. No further particulars.

UAROO.

The belt of country in which the deposits occur in this district consists of crystalline schists associated with granitic gneiss, and is said to have a width of about fifty miles, and to extend north and south for about 150 miles. The ore deposits occur in the schists at, or close to, their junction with the granitic gneiss, and generally have a north-westerly trend with an underlay to the north-east. As far as reports go, the lodes vary in thickness from a few inches up to three feet. A number of these deposits are known to occur in the district, and some very good ore has been obtained, but no reliable information is available.

Weston's and Metawandy Creek.—Good grade copper ore has been reported from both these places, but no particulars are available.

Scotts (19 miles east of Mt. Stuart).—Some nice ore is being raised here and is said to be worth 30 per cent. copper and 12oz. of silver. No particulars as to the nature of the deposit.

Red Hill.—Several leases have been taken up in this district ely and the results are said to be very promising.

Assays of Samples of Copper Ore from Uaroo and Red Hill, made in the Geological Survey Laboratory.

Locality.	Nature of Ore.	Copper, per cent.	Lead, per cent.	Gold, ozs. per ton.	Silver, ozs. per ton.
Uaroo ...	Chalcocite, malachite, cuprite	54·69	...	*Nil*	21·09
Do. ...	do. do.	62·35	...	*Nil*	39·77
Do. ...	Cuprite, malachite, chalcocite, chrysocolla	54·11	...	*Nil*	34·81
Do. ...	Pyrolusite and tenorite ...	4·22	...	*Nil*	6·45
Do. ...	Malachite, cerussite, etc.	29·88	4·9	trace	29·55
Do. ...	Malachite, cuprite, iron oxides, and quartz	25·14	...	„	1·63
Do. ...	do. do.	5·71	...	*Nil*	41
Do. ...	do. do.	39·70	...	*Nil*	*Nil*
Do. ...	do. do.	9·21	...	*Nil*	trace
Red Hill...	Malachite, cuprite, quartz	24·90	...	trace	2·45
Do. ...	do. do.	18·68	...	„	trace
Do. ...	do. do.	17·20	...	*Nil*	*Nil*
Do. ...	do. do.	46·24	...	*Nil*	*Nil*
Do. ...	do. do.	35·76	...	*Nil*	*Nil*
Do. ...	do. do.	3·80	40·6	·040	1·05

DAY DAWN.

Croesus G.M.L. 14D and *San Diego* 2D.—A couple of small lodes have been worked here and a few tons of ore taken out. The thickness of these lodes was only about 6 or 9 inches, and they appear to have been merely small quartz reefs carrying near the surface a high percentage of carbonate of copper. They are not likely to develop into anything of any great importance.

Returns from San Diego are 15.65 tons of ore, valued at £167.

YALGOO.

A deposit of fair grade copper ore is said to have been worked at Wadgingarra, near Yalgoo. From reports it appears to have been a quartz reef with carbonate ore disseminated through it. No definite information concerning it is available, however.

M.L. 6, *Olive Queen* at Wadgingarra has produced 31.91 tons of ore containing about 3 per cent. of copper.

CUDDINGWARRA.

Four miles to the north of Cuddingwarra Messrs. Carlyon and Logie are working a copper show, from which they have obtained five tons of ore which is expected to give 25 to 30 per cent. copper. A crosscut is said to have gone into the lode for 13ft. without reaching the walls.

Twin Peaks.—Copper ore has recently been reported from this locality, and 13.50 tons of ore have been treated for a return of 2.27 tons of metallic copper. (P.A. 105.)

GABANINTHA.

Tamarack Copper Mines, Ltd., M.L. 5M.—Two shafts have according to reports, been put down to a depth of about 30ft. (January, 1907). These have proved the lode to be about 4ft. in thickness and of an assumed average value of 8 to 10 per cent. of copper, and 2 to 4dwts. of gold. No official detailed particulars are available as to the nature or extent of these deposits, but the owners appear to think them valuable, as they are at present proposing to erect a reverberatory furnace on their property.

The Lady Alma, 4M.—The lode on this property is reported to vary from 4in. to 5ft., and the ore to be worth 16 per cent. of copper. 6.50 tons of ore have been treated for a yield of 1.50 tons of metallic copper, valued at £135.

The Duffer, M.L. 9M adjoins the Lady Alma on the north. A shaft has been sunk to a depth of 75ft. on the lode. Assays taken at various depths in the shaft returned an average of 9 per cent. of copper; for the last five feet the shaft is said to be in ore worth 40 per cent. copper; at this point the ore body is 12in. in thickness.

Tamarack Central, M.L. 7M.—The lode is reported to run through the whole length of this lease and has been proved by costeens. Size and value of lode not reported.

The Golden Hope, 676M.—At present worked as a gold mining lease. At the 60ft. level, where the present main workings are, the lode is said to be 2ft. wide and to carry 18dwts. of gold and 9 per cent. of copper. The ore body is a quartz reef with carbonates of copper disseminated through it.

Mountain View G.M.L. 379M.—This property is also being worked as a gold mining lease. The main shaft is down 220ft. The lode is said to be 5 feet wide, and the shoot of payable ore 150ft. long. This body of ore is said to be worth 10 per cent. of copper and 18dwts. of gold. This is also a quartz reef carrying bunches of copper ore. 127.00 tons of copper ore from this property have been treated for a yield of metallic copper, valued at £2,681.

CENTRAL.

MURRIN MURRIN.

This most promising district contains a copper mine that has yielded one-half of the ore raised in this State, and also one-half of the total copper production, if the high returns reported from the Northampton mines (before official records were kept) are omitted.

The whole of the mineral belt is greenstone, with quartz, jasper, and ironstone veins showing little or no copper indications at the surface; therefore it is highly probable that many of the ferruginous lodes will, upon development. prove to be the caps of rich cupriferous deposits; these should therefore be prospected by shaft sinking.

The Mount Malcolm Copper Mine at Eulaminna (late Anaconda) is owned by the West Australian Copper Company, Limited, the property consisting of M.Ls. 4f, 5f, 11f, and 12f, which include the extinct Mt. Malcolm Copper Mine, M.L. 10c, which in 1904 passed into the hands of the Murrin Murrin Copper Mines, Ltd., the latter apparently having been so unsuccessful that the company was wound up, the plant consisting of a large water jacket furnace, etc., removed, and the leases sold.

The present management has been much more successful, having discovered and opened up two new bodies of rich ore, one in the old northern workings and one in a winze sunk from the crosscut at the 80ft. level in the magazine shaft; the size of this latter is not at present known, but it has been sunk on 32ft. and crosscut 7ft. in solid ore.

The ore channel has been opened up at three points in a length of 1,300 feet, the northern portion of which apparently follows a jasper bar, the whole striking in a north-easterly direction with an average underlay of 65 degrees to the eastward.

The ore in this channel has been concentrated into zones of enrichment which can more accurately be described as bonanzas than shoots, three of which have been worked at the surface by open cuts for lengths of 130, 110, and 200 feet, and to depths of 30, 20, and 180 feet, the ore body in which varies from 5 to 40 feet in width, and in value from 5 to 70 per cent.

The oxidised zone, rich in carbonates, extends downwards to the ground water level which varies from 90 to 110 feet, according to the elevation of the surface, whilst below this the ore changes into black sulphides with iron pyrites which continue down as far as present developments have taken place.

The two sulphide bodies last discovered did not outcrop; the one in the northern workings being met with at a depth of 90 feet, and the one in the middle workings at 110 feet.

There are two reverberatory furnaces constantly at work upon this mine which produce 40 tons of 50 per cent. matte per week, the ore neither requiring dressing nor fluxing. A third furnace is nearly complete, and it is contemplated erecting a blast furnace almost immediately in order to treat the large quantities of low-grade ore which exist in the old workings and in the oxidised zone.

Development is being rapidly pushed on in order to determine the nature of the lode at a depth, where the ore will most probably change into copper pyrites below the zone of saturation.

From this mine, from its inception, up to July, 1907, 40,082 tons of ore have been raised, which realised £177,305, whilst no ore has been so far stoped below the 190ft. level.

Murrin Murrin Nangaroo M.L. 6F.—No particulars are available concerning this property. The returns from it up to the end of 1906 are 1,080.52 tons of ore, valued at £23,769; the bulk of the ore averaging about 20 per cent. of copper.

Mt. Morven, 66F.—This property has produced 11.53 tons of ore, valued at £163; the ore averaging 20 per cent. of metallic copper.

In addition to the above properties there are said to be several promising shows near the "Princess Alix." On one of these there is said to be a body of ore 12ft. wide worth 12 per cent. copper, whilst others are said to contain small but rich veins.

GOONGARRIE.

Copper ore has been raised in small parcels from one or two leases in the Goongarrie district. The deposits occur within an area of greenstones of the usual West Australian type. No particulars are available as to the exact size and nature of the deposits however, but it would appear as if they were merely bunches of copper ore occurring in association with quartz reefs.

The Providence Copper Syndicate, M.L. 13z, has a property here which is said to have produced ore containing 30 to 40 per cent. copper, and also carrying a fair percentage of gold and silver. Production to end of 1906 is 4.70 tons of ore for a return of .42 tons of copper, valued at £33.

BROAD ARROW.

Copper ore has also been raised here, but no particulars are to hand as to the nature of the deposits. They are within the greenstone area, and are apparently of no great size or value.

The Emerald Copper Mine, M.L. 16w (5 miles S.W. of Broad Arrow), recently sent a parcel of 5 tons of ore to Fremantle for treatment.

PADDINGTON.

Copper ore has also been reported from this centre, but no particulars are available.

SOUTH-WEST.

NORTHAMPTON DISTRICT.

The Northampton Mining District includes the centres of Geraldine, Northampton, Narra Tarra, and Oakagee, and the general features of these places are to all intents and purposes the same.

The area within which the copper deposits are found is essentially granitic, and it outcrops from beneath a series of sedimentary rocks consisting of sandstones, grits, conglomerates, etc. These granitic rocks consist of granite, gneiss, mica schists, quartz schists, etc., intersected by veins and masses of pegmatite and diorite dykes, they are also traversed by sheeted zones of garnetiferous gneiss, these having a general trend about north-west and south-east and being usually very persistent. The rocks of this series outcrop from below the overlying sedimentary rocks at intervals for a distance of about 110 miles, extending from Geraldine, on the Murchison River, in the north to the Arrino in the south, and having a width of about 30 miles.

The most important structural feature in the Northampton district is the system of basic dykes with which the whole area is seamed. These exhibit a remarkable parallelism, having a general trend north-east and south-west; in thickness they vary considerably—from a few feet to a couple of chains—but many of them are of great length and they have in instances been traced across country for a distance of over 10 miles.

The lodes of the district are almost invariably found running parallel to the strike of these dykes, and are often in close association with them.

Generally speaking, these lodes consist of bands of crushed granite ("formation") in which run small quartz reefs; a little ore (copper or lead) is always found disseminated through this quartz but the bunches or shutes of payable ore are usually found in the formation, lying alongside the quartz reefs.

In thickness these bunches vary from next to nothing up to a couple of feet, and both longitudinally and vertically are just as variable.

Wanerenooka Mine (situated on the northern boundary of the township of Northampton, on Block 27, etc.).—This was the first copper mine worked in the State, a good deal of work was done in the early days, but like nearly all the other mines in this district it was idle for a number of years, but some five years ago it was unwatered by an English company, who did a considerable amount of prospecting at the bottom level without result. The deepest workings are down to a depth of 240ft., but most of the ore was taken out nearer the surface. Good ore was said to be standing both in the 138ft. and 180ft. levels, but this did not prove to be the case, and in consequence the mine was again allowed to fill with water. The lode is 30ft. in width with smooth well-defined walls ; it carried a payable body of ore on the hanging wall and another on the footwall, each about a foot in width ; its trend is about north-east and its dip to the eastward.

Derby Syndicate (part of Wanerenooka property).—There is a lode which consists of a small quartz reef carrying copper pyrites.

Victoria Copper Mine, M.L. 38 (situated about a mile and a quarter from the railway station).—The lode is about 7ft. wide and can be traced on the surface for a distance of about two miles, and is said to have carried about 2ft. 6in. of payable ore, consisting principally of sulphides. Several shafts were sunk on the property to a depth of about 60ft. and the lode was opened up for a length of 200ft. and then abandoned. The trend of the lode is about north-east.

Wheal Margaret, M.L. 12, *etc.*—Situated about a mile north-east of the railway station, the deepest workings being down about 200ft. on the underlay, but most of the ore was taken out from near the surface. The lode can be traced for a considerable distance, and is said to have been from 7in. to 2ft. in width, carrying some very rich ore, mostly blue and green carbonates; sulphide ore was beginning to come in at the bottom of the shaft.

A bore was put down by the Government in 1902 to test the permanence of this lode at a depth, but the results were negative.

Wheal Fortune, Block 334, *etc.* (about four miles west of the townsite).—The main shaft is said to be 300ft. in depth, but is badly caved in as are most of the other workings; the property was abandoned about 40 years ago. The lode was worked for both copper and lead; the copper ore appears to have occurred in bunches, principally of blue or green carbonates.

Wheal Beta, M.L. 44, has been opened up to a depth of from 50ft. to 60ft. but no particulars available.

Yanganooka Mine, Blocks 32, *etc.*—Two parallel lodes on the property striking north-east and south-west and dipping steeply to the north-west. Western lode has been opened up to a depth of 180ft. The mine has not been worked for 35 years, and no further particulars are available. The dressed ore gave 17 to 34 per cent. of copper.

Wheal Alpha Mine, M.L. 9.—Also abandoned for many years. Has been opened up by means of several shafts to a depth of about 60ft. The lode on the surface is about 18in. in width.

Martin's Spring Mine, Block 312, has been opened up to about 50ft.; lode said to have been 25ft. in width carrying good bunches of copper ore, some of which is reported as yielding 55 per cent. copper.

Narra Tarra Copper Mine, Blocks 118 *and* 119.—Opened up to a depth of about 30ft., large well-defined lode running north-east and south-west, and dipping to the north-west. Lode carried copper at the southern end and lead at the northern. Some good ore said to have been obtained previous to 1865, when the mine was abandoned.

Gwalla Copper Mine, Blocks 140, 14, *etc.*—Two parallel lodes striking north-east and south-west, and dipping to the south-east. Several shafts have been put down on the property, the deepest to about 200ft., and a lot of work is said to have been done. No particulars are available, as the property has been abandoned for years. (This mine is now being re-opened.)

Yankee Crossing Copper Mine.—Small but rich shute of ore said to have been worked here to a depth of 40ft.

OAKAGEE.

White Peak Copper Mine, Block 4.—Abandoned since 1858; bunches of rich ore said to have been obtained.

Gelirah Copper Mine, Block 328.—Two parallel lodes on the block, of these the eastern carries copper ore and the western lead ore. The copper lode outcrops for a distance of about 900ft. and has been opened up for a depth of 120ft. A large amount of ore is said to have been taken out prior to 1872, when the mine was abandoned.

GERALDINE.

Geraldine Copper Mine, M.L. 10 *and* 11.—The deepest workings are down to a depth of 150ft. and a lot of work has been done. The lode is said to have been very large, with pockets of good ore. Ore sent away in 1900 yielded 28 per cent. copper. Since 1899 the amount of ore raised from this property as reported to the Mines Department is 136.50 tons, valued at £1,992. There are no records of the returns previous to 1899.

Ouraka Copper Mine.—Opened up to a depth of 60ft. No particulars available.

Hennings Copper Mine.—A few tons of rich ore said to have been taken out near the surface from a small but rich lode.

Tambarra Copper Mine.—Prospecting show in 1901. No particulars available.

Gibson's Copper Mine.—Large low-grade lode has been opened up to a depth of about 40ft. Small rich pockets said to occur in this lode.

Table of Assays of Copper Ores from the Northampton District, made in the Geological Survey Laboratory.

No.	Mine.	Locality.	Nature of Ore.	Parts per 100.		Ozs. per ton.	
				Copper.	Lead.	Silver.	Gold.
31 5 ..	Wanerenooka	Northampton	Chalcopyrite and quartz	6·54	*Nil*		...
M. 183	Nooka ...	Do. ...	Chalcopyrite, galena, and quartz	5·34	8·6	*Nil*	*Nil*
	Racecourse ...	Do. ...	Cupriferous gossan ...	8·08	...	0·87	*Nil*
3905...	Derby Syndicate	Do. ...	Chalcopyrite and quartz	24·01	*Nil*	1·76	0·5
3906...	Derby Syndicate	Do. ...	do. do.	13·52	*Nil*	0·41	*Nil*
673 ...	?	Do. ..	Malachite, oxide of iron, etc.	18·63	...	2·29	Trace
674 ...	?	Do. ...	Malachite, oxide of iron, etc.	15·18	8·8	*Nil*	*Nil*
675 ...	?	Do. ...	Malachite, oxide of iron, etc.	14·48	...	*Nil*	*Nil*
676 ...	?	Do. ...	Malachite, oxide of iron, etc.	31·94	...	2·45	Trace
677 ...	?	Do. ...	Malachite, oxide of iron, etc.	37·85	...	...	...
4131...	McGuires ...	Oakabella ...	Galena, chalcopyrite, and quartz	1·75	39·5	*Nil*	*Nil*
3925...	Narra Tarra Copper	Narra Tarra	Azurite and quartz ...	14·61	*Nil*	2·33	0·11
3926...	Narra Tarra Copper	Do. ...	Azurite, malachite, and quartz	8·98	*Nil*	1·07	Trace
4281...	Gelirah ...	White Peak	Chalcocite, quartz, and iron oxides	21·99	...	...	...

As no official record was kept of the production from the various metalliferous mines in the State previous to 1899, it is practically impossible to arrive at the amount of ore produced by the various Northampton District mines, as the majority of them were abandoned before this date. The following short table, however, is available, and the total quantity of ore raised from the district and entered for export up to the end of 1898 will be found in the table on page 48.

Statement of Copper Ore raised from some of the Northampton Mines.

Name.	Date.	Quantity of Ore raised.			Total Value of Ore.		
		tons.	cwt.	qrs.	£	s.	d.
Gwalla	1863	12	3	0	260	4	8
Do.	1864	132	14	0	3,956	9	6
Do.	1865	88	11	0	1,866	16	9
Do.	1866	163	13	0	1,044	9	8
Do.	1867	172	7	0	2,976	1	1
Do.	1868	263	1	0	3,664	19	8
Do.	1869	70	18	0	904	7	1
Yanganooka	1866	292	0	0	3,725	16	7
Do.	1867	164	18	0	2,165	3	7

YANDANOOKA MINING DISTRICT.

This district includes Yandanooka, Mt. Misery, and Arrino. It is scientifically interesting on account of the occurrence of copper ores in sedimentary rocks which are apparently a southward extension of the carboniferous Irwin River beds. These beds are here composed of conglomerates, quartz girts, sandstones, quartzite, and volcanic tuffs. They are intruded by a narrow band of granite, the outcrop of which is never more than a mile wide and runs almost due north and south. On either side of this granite the sediments dip more or less greatly away from it. Both granite and sediments have been sheared and copper ore appears in the shear zones in mica schist (sheared granite), sandstone, and tuff.

Several copper deposits were worked here many years ago but nothing which could really be called mining has been done, and nearly all the shows are now abandoned. The following is a brief description of the principal ones now in existence.

Cyprus Copper Mine, M.L. 38.—This is the same as old M.Ls. 4 & 12, known as Cheyne's or the Money Mia Mine. It is close to the Arrino Railway Station, and from the outcrop of the deposit some very rich ore was said to have been obtained many years ago. The upper part of the deposit consists of a band of sandstone impregnated with malachite, and, at a slight depth, with chalcocite. This deposit cuts across the bedding of the sandstone, dipping west towards the granite into which it passes at a depth of about 40ft. Its character below that depth is not definitely known, but, judging from other deposits in the district, it is a shear zone in the granite impregnated with copper ore. Within the sandstone the deposit is irregular in form and somewhat extensive, as the more porous rock has allowed the copper-bearing solutions to diffuse to some distance on either side of the true ore channel. A sample of chalcocite from this mine gave the following results on assay :—Copper, 75.65 per cent.; silver, 19.92ozs. per ton ; gold, 0.054ozs. per ton.

The only output from this mine which has been officially recorded is 25 tons of ore in 1899, valued at £300.

Arrino Proprietary Mine, M.Ls. 2PP & 3PP.—These leases occupy Loc. 342, and are identical with the mine known variously as Gill's or Baxter's. The occurrence of ore here is identical with that at the Cyprus Copper Mine. Very little work has been done on this property since Mr. Campbell reported on it in 1903, when he said :—

"Baxter's Mine is probably about 5 chains east of the granite. Here three shafts have been sunk, with an opencut at the northernmost one ; two are 60ft. deep. The strike of the sandstone is here 15 degrees, and dip 58 degrees to the east, with cross-faces 134 degrees, dipping 70 degrees to the west. At the new main shaft the depth is 41ft., at which level a crosscut 21ft. long is being put in, the sandstone showing staining of copper. It passed through the lode, where a bunch of black sulphide of copper was met with." The bearing of the lode is 150 degrees, and it underlies 60 degrees to the west towards the granite. Assays of sandstone impregnated with carbonates of copper from this mine gave for copper, 9.72, 9.89, 22.77, 4.31, 20.85, 4.28, 3.91, and 4.39 per cent.

No record appears to have been kept of ore raised from this mine.

Gordon's Mine.—About three and a half miles on the south side of Yandanooka Siding, and close to the railway line—on the east side—a discovery of copper ore has recently been made. The deposit is in the belt of tuff, and so far is only in the prospecting stage. A body of ore from twelve inches to three feet in width has been exposed in a series of shallow costeens, and this, in one place, contains some rich bunches of carbonate and sulphide ore. The samples of ore gave on assay results as follow :—

No. 1. Malachite and chalcocite.—Copper, 33.16 per cent.; silver, 16dwts. per ton ; gold, 21grs. per ton.

No. 2. Chalcocite.—Copper, 55.53 per cent.

No. 3. Carbonate ore.—Copper, 9.00 per cent.

The following figures show the amount of copper ore raised in the Yandanooka district, as reported to the Mines Department to the end of 1906 :—

Centre.	Name and No. of Lease.	Tons of Ore.	Value.
			£
Arrino	Wheal Dodd, 5	10·00	80
Yandanooka	Arrino Leases, 3, 4 ...	25·00	300
Do.	Lady Bertha, 7 ...	3·00	7

PHILLIPS RIVER DISTRICT.

The rocks of the Phillips River District, as far as examined, consist of a series of granites and greenstones similar to those found in the Southern Cross and other mining fields of West Australia. It would appear from the evidence, and from what is known on the other fields, that the greenstones are the older rocks, and that they have been intruded by the granites, and that these in turn have been intruded by a series of granitic and pegmatite dykes, and also by a later series of basic greenstone dykes.

Considerable schistosity is noticeable in the main body of greenstones at, or close to, their junction with the granite, and the same feature is also apparent in places in the granite, principally in proximity to the basic dykes.

The lodes appear for the most part to occur within the area of the greenstone schists, close to their junction with the granite, in some cases they are found right along the junction, greenstones forming one wall of the lode and granite the other. When in the schists the lodes are found invariably running with the foliation of these.

From the description of them, the lodes would appear to consist of quartz reefs occurring in narrow bands of highly altered schist, carrying more or less copper ore, this usually occurs in irregular-sized bunches or shoots of rich ore, both in the quartz and also in the lode material (schist) ; a little ore is also usually disseminated through the quartz. In the oxidised portions of the lode this rich ore generally consists of oxides and carbonates of copper in a gangue of oxide of iron : but at a depth it consists of a mixture of iron and copper sulphides, usually mixed with more or less quartz.

The district can, for the sake of convenience, be divided into the three centres of (1), Kundip ; (2), Mt. Desmond ; (3), Ravensthorpe.

KUNDIP.

Red, White, and Blue, M.L. 60.—Three lodes have been proved to exist on this property containing copper. The main line runs about east and west, and underlies to the north ; the lode matter varies in thickness from 18in. up to as much as 12ft., and probably averages about 3ft. The ore is siliceous, but, at times highly ferruginous, and carries bunches of blue and green carbonates.

The other two lodes are from six inches to three feet in thickness, and consist of quartz and ferruginous lode stuff containing oxides and carbonates of copper. All the lodes carry gold as well as copper.

From latest reports it would appear that this property has been opened up to a depth of slightly over 100ft., and that the main lode has been proved in the workings for a length of 400ft., and on the surface for 600ft. Assays taken from the bottom workings give from 2 to 13 per cent. of copper and 1oz. to 3 ozs. of gold over a width of from 2ft. to 2ft. 6in., the average width of the lode throughout is stated to be 2ft. 3in., and its average value 6.3 per cent. of copper and 42dwts. of gold. Up to the end of 1906 the property has produced 233.02 tons of ore, valued at £1,660.

Harbour View, M.L. 52.—A strong lode runs through this property on a bearing slightly east of north, having a fairly flat underlie to the west, it varies in thickness from 6ft. to 12ft., and has good smooth walls, the surrounding country being a greenstone schist. The ore is patchy, some very nice bunches of carbonate ore being met with in a highly ferruginous matrix; the bulk of the ore is highly siliceous, and when low in copper is sent to the battery as an ordinary gold ore. The mine is worked for both gold and copper.

Harbour View, Leases 52, 94, have produced to the end of 1906, 732.04 tons of ore, valued at £5,855. Now included in Ravensthorpe G.M. Syndicate.

Omaha Mine, M.L. 132.—This lease adjoins the previous one on the north end, and the workings are on the same lode, which is here six to seven feet in width, and contains some nice oxide and carbonate ore. The property has produced 9.15 tons of ore, of a total value of £69.

Mt. Stennett Mine, M.L. 108.—The lode here runs about north and south, with a flat underlay to the east, and is in soft schist country, with well-marked smooth walls. It is about 6ft. in width, with a vein of from 12in. to 30in. of highly ferruginous matter with oxides and carbonates of copper, the balance of it being highly siliceous, and very low grade. Both gold and copper occur in the lode.

This lease has yielded 244.68 tons of ore for copper, valued at £2,058, the last parcel yielding about 10 per cent. of copper.

MT. DESMOND.

Elverdton Welcome Stranger, M.L. 139.—The lodes here run about north and south, and are close to or along the junction of the granite and the schists. On this property there are three parallel lodes all small and generally very siliceous, containing small bunches of carbonate ore. Most of the veins are in the granite. Up to the end of 1906, 5.31 tons of ore have been produced of a total value of £42.

Elverdton South Mine, M.L. 168, 106.—This property is on the same line of lode formation as the Elverdton. The lode is here on a narrow belt of greenstone schist enclosed in the granite, and varies a good deal in size, being in one place as much as 10ft. in thickness; it is fairly siliceous, and carries sulphide ore where opened up at the 80ft. level; in the upper levels the ore is red oxide and carbonate. Some very rich ore was got near the surface, but the bulk of it is rather poor, and would require concentrating before smelting. Gold is also found in appreciable quantities.

Returns—51.32 tons of ore for copper, valued at £457. Now included in Phillips River Options Co.

Elverdton Mine, M.L. 95.—A belt of dark highly-altered schist forms the lode matter on this lease and runs about north and south, being enclosed in granite country. The schist in the lower levels contains bunches and lenses of copper and iron sulphides which in the upper levels have become oxidised and formed bunches of rich ore consisting of oxides and carbonates of copper in a matrix consisting principally of oxide of iron. The full width of the lode material is apparently about 15ft. The ore on the lower levels (sulphide zone) becomes highly siliceous and much lower grade, this occurring below the 70ft. level.

The same lode has been opened up further south where the ore body is from two to four feet in width but not too regular in value.

The picked ore from this property is excellent smelting material, but the seconds have a highly siliceous gangue.

Has produced up to end of 1906, 2,946.02 tons of ore for copper valued at £22,657 ; last yield averaging about 12 per cent. copper. Included in Phillips River Options Co.

Baden Powell, M.L. 99.—The lode here is in soft schist country but is small and siliceous, it however contains some nice bunches of ferruginous carbonate ore, and is also said to carry high gold values.

Mount Desmond Mine, M.L. 109.—The lode here may possibly be the same as that worked on the Baden Powell Lease; it is also in schist country and runs about north and south, dipping to the east. It has been traced on the surface for about 300ft., and is from 4ft. to 5ft. in width. At the south end it is mostly composed of quartz, but going north it contains some nice carbonate ore in a highly ferruginous matrix. At the north end of the property apparently this same lode has been opened up again to a shallow depth, it is here about 3ft. in width but very siliceous and low grade.

There are two other small parallel lodes on the property also containing a little copper ore. Total production to the end of 1906 was 683.59 tons of ore for copper, valued at £7,560. Now included in Phillips River Gold and Copper Co., Ltd.

P.L.P., M.L. 199.—The lode here is alongside a basic dyke penetrating the granite. The ore is in small veins and bunches, and consists of carbonates at the surface but turns into sulphide at a shallow depth. Has produced up to the end of 1906, 110.85 tons of ore, valued at £1,272, the ore raised last year yielding about 20 per cent. copper.

RAVENSTHORPE.

Great Oversight, M.L. 210 (154).—In the bottom levels of this mine the lode matter is a dark schist with some quartz and copper pyrites and runs up to 6ft. in width; some of the ore is very rich and good smelting material, especially in the oxidised portion, where some very good carbonate ore was obtained in a highly ferruginous matrix; a great portion of the lode is highly siliceous and low grade, and would require concentration before smelting. Up to the end of 1906 has produced 76.89 tons of ore of a total value of about £700.

Last Chance Mine, M.L. 116.—A well-defined lode runs through this property on a bearing a little north of west, underlying fairly steeply to the south. This lode is in soft schist country with smooth clayey walls, and is from 2ft. to 8ft. in width—generally 3 to 4. Sulphides are making their appearance at water level, and the ore is fairly good (17.18 per cent. copper) and good smelting material. The best ore near the surface was carbonate, in a gangue of brown iron ore ; the poorer ore was very siliceous. A second lode also exists on this lease, this is about 3ft. wide and highly siliceous, but it contains some fairly rich patches of carbonate ore in a matrix of iron oxide.

Has produced up to the end of 1906, 772.40 tons of ore for copper valued at £7,230, the last parcels averaging about 16 per cent. of copper.

Last Chance Proprietary, M.L. 200 (120).—The lode on this property runs a little west of north, and dips to the west.

It is in schist country and has been picked up on the surface at intervals for about 10 chains: its full width is nowhere exposed, but it would appear to be at least 3ft. to 4ft. The best ore is a mixture of oxides and carbonates of copper in a highly ferruginous gangue fairly free from silica, and occurs in bunches and veins up to 2ft. in width; the lower grade ore is, however, fairly siliceous. Sulphides began to come in at about 50ft. Has produced 136.68 tons of ore for copper worth £1,194, the ore being worth 10 to 13 per cent. of copper.

Emily Hale Mine, M.L. 124.—There are two lodes on this property, the main one running about north and south, and the other about north-west and south-east. The north and south lode is about 3ft. in width but not very well defined, it consists of quartz with oxide of iron and copper carbonates, the latter turning into sulphide at water level.

The second lode is also about 3ft. in width and carries some nice bunches of ore consisting of oxide of iron and carbonates of copper. Not much work has been done on either line. Total production to end of 1906 is 132.27 tons of ore, worth £1,192, and averaging 15 to 16 per cent. copper. Now included in Ballarat M.L. 205.

Kilmore Mine, M.L. 119.—Several lines of lode run through this property all carrying more or less copper. The lodes are mostly oxide of iron with bunches of carbonate ore, and are in hard mica schist. The main line has smooth, well-defined walls, and is from 6ft. to 7ft. in width where opened up; veins of carbonate ore were found in this down to about 40ft., where they were replaced by sulphide, some of the veins being up to 15in. in thickness. The ore would require hand-picking and concentration before smelting. Seventy-two point seventy-eight (72.78) tons of ore produced for copper valued at £532.

Federal Mine, M.L. 131.—The lode here runs about north-west and south-east through a mica schist, and is from 18in. to 2ft. in width ; it carries some nice bunches of carbonate ore in a gangue of iron oxide, but the bulk of the ore is very siliceous.

There is also a second lode on the property consisting of dense reddish-brown hematite, carrying a small amount of copper carbonate ; this lode is about three feet in width, and apparently too low grade to be of much use as a copper deposit, but the ironstone would probably prove useful as a flux. The property has produced 8.67 tons of ore of a total value of £53.

Mt. Allan Mine, M.L. 31.—A large lode of dense brown hematite has been opened up here, carrying at a slight depth a large amount of iron pyrites. .

Mt. Benson Mine, M.L. 175 (late *Kingston Mine, M.L.* 143).—There are several lines of lode of varying sizes and value on this property, running through schist country on a bearing nearly east and west. The western lode is small and very siliceous, but some nice bunches of ore were obtained near the surface, these consisting of carbonate of copper and iron oxide. The west lode is also mostly quartz, with bunches of good fluxing ore ; this lode also carries good gold values. Several small parallel veins, containing a little copper ore have been exposed between the two main lines, but no work has been done on them. Up to the end of 1906, has produced 689.69 tons of ore, valued at £4,578, the last parcel averaging 10 per cent. copper. Now included in Phillips River Gold and Copper Co., Ltd.

Mt. Benson Extended, M.L. 195.—On the same lode, or a parallel one, as the Mt. Benson ; not much work done, but some nice bunches of oxidised ore have been obtained. Production to end of 1906—2.55 tons of ore, valued at £21.

Rio Grande (adjoins the Benson).—Main shaft down 75ft., and a crosscut at 60ft. is said to have cut a lode 12ft. wide carrying fair copper ore ; a winze from the bottom level is in ore worth about 8 per cent. of copper.

Mary Mine, M.L. 7.—There are several lines of lode on this lease, the principal one being near the western boundary. This lode is from four to five feet wide, with good walls, and runs nearly east and west, underlying steeply to the north. Lenses and bunches of carbonate ore mixed with oxide of iron occur throughout this lode to a depth of about 20ft., when they are replaced by sulphide ore. The general quality of the ore is good fluxing material, but parts of it are very siliceous. Several other lines of lode have been opened up, these varying a good deal in size, but being generally smaller than the main line, they are mostly highly siliceous, but contain some nice bunches of mixed sulphide and carbonate ore in a gangue of iron oxide. The water level is about 80ft., the water being salt. Production to end of 1906 is 768.42 tons of ore for copper worth £5,492.

McMahon Mine, M.L. 123.—The ore which has been raised from this property is oxide of iron with oxides and carbonates of copper ; the poorer ore is very siliceous. The total ore production from the lease is 5.02 tons, of a total value of £38.

Mt. Cattlin Mine, M.L. 15.—A fine strong lode runs through this lease on a bearing a little north of east, having a slight underlay to the north. The surrounding country is greenstone schist, and the lode consists of a highly altered band of the same material, carrying veins and masses of copper ore. At about the 40ft. level the lode was about 10ft. in width, with veins of good-grade copper ore from one to four feet in width ; at times much quartz is present, and this, though low in copper, is said to carry good gold values. About 150ft. further east the same lode is opened up again, and at the 50ft. level is 14ft. in width, with three to four feet of good copper ore on the footwall side, and about 8ft. of quartzose ore carrying a little sulphide and carbonate ore on the hanging wall side ; this portion of the lode also carries some free gold. At about 100ft. the lode has become much more siliceous, and carries a good deal of copper pyrites, and is said to also carry about 10dwt. of gold. The average value of the ore is here said to be six to eight per cent., which is rather low, as the sulphide is generally finely impregnated through dense hard quartz.

Later reports from this property state that the stopes above the 100ft. and 200ft. levels are in ore eight to nine feet wide, carrying three to six per cent. of copper and 3dwts. of gold. During February of the present year 937 tons of ore were smelted for 43.43 tons of copper and 190ozs. of gold. There are said to be about 670 tons of ore on the dump worth from four to five per cent. of copper.

Production to end of 1906 was 1,545.32 tons of ore for copper, rth £9,362, the ore averaging six to seven per cent. copper for the last few parcels. Included in Phillips River Gold and Copper Co., Ltd.

Andante Lease, M.L. 207 (61).—On the same line as the Mt. Cattlin. The ore is very siliceous, and poor in copper values; gold contents of stone said to be from 10dwts. to 39dwts. Not much work done.

Grimsby Mine, M.L. 110.—The lode on this lease also runs nearly east and west, and consists of a belt of highly altered schist some three to four feet in width. The ore occurs throughout this in bunches, sometimes up to ten feet in thickness; it consists principally of copper pyrites, and is often very rich, but would require sorting from the lower-grade lode stuff.

Ore production to date is 5.85 tons of ore of a total value of £34.

Marion Martin Mine, M.L. 16.—Two east and west lodes about 200 yards apart have been opened up on this property. The more important one of these is from three to four feet in width, and carries bunches and veins of rich ore up to 18in. to 2ft. in thickness. This in the lower levels is mostly iron and copper sulphides, and in the upper is oxide of iron and carbonate of copper. This rich ore occurs in short shoots, and the lode between them is too low-grade to be of much value without concentration.

Production to end of 1906 is 865.69 tons of ore for copper valued at £6,650. Included in Phillips River Gold and Copper Co., Ltd.

Sunset Mine, M.L. 115.—Here a lode some six or eight feet in width has been opened up; this carries veins of copper ore from 18in. to 2ft. in thickness, and consisting of a highly siliceous iron oxide with carbonate of copper. At a little depth the ore becomes quartzose with sulphides of iron and copper. Not much work done.

Has produced up to the end of 1906, 477.76 tons of ore for copper worth £3,109, the ore carrying about 7 per cent of copper.

Surprise Mine, M.L. 114.—On this block there is an east and west lode running through greenstone schist country, apparently close to its junction with the granite; this lode is from three to six feet in width, and contains veins and bunches of copper ore up to 20in. in width; this ore consists mostly of carbonate of copper mixed with iron oxide, and is said to average about 20 to 25 per cent. copper.

This lease has produced up to the end of 1906, 396.07 tons of ore for copper, valued £2,947, the ore averaging about eight per cent. copper.

Mosaic, M.L. 237.—There is a very large "formation" on this property, and in this is a small vein carrying rich fahlore (arsenical and antimonial sulphide of copper); this carries high silver values, results up to 100ozs. per ton being obtained. Very little work has been done.

Production to end of 1906 is 53.48 tons of ore, valued at £310; and 1.67 tons of ore for a return of .19 tons of copper.

J. Beck's show, about a mile to the north of the Mosaic, is said to contain a lode 15in. in width carrying 23 per cent. of copper.

The Hillsborough is reported to have at the 100ft. level a lode 13ft. wide, from which ore carrying 14-15 per cent. copper and 3ozs. of gold can be obtained.

WEST RIVER.

The cupriferous belt is said to here run about east and west, and to consist of weathered granite with bands of ironstone and schist and occasional deposits of ironstone and limestone. The lodes run about north and south.

Copper King.—The lode here has been opened up to about 150ft. and consists of a large quartzose reef carrying good values. The lode is the full width of the shaft, viz., 4ft. to 5ft., but its width beyond this has not been proved. The drive at the 150ft. level shows the lode to have an average width of about 2½ft. and to be worth about 15 per cent. copper.

A second parallel lode exists on the lease; this is about 2ft. in thickness on the surface and highly ferruginous. No work has been done on it.

The Boomer.—Parcels sent to Wallaroo gave a return of about 20 per cent.

Myrtleford.—The property is said to carry two lodes, a north and south one and an east and west, or cross lode. The main line is traceable for a length of 600ft. and has an average width of 4ft., and is said to carry 7 per cent. copper and 5dwts. of gold. A shaft which has cut the lode at 45ft. shows it to be 5ft. in width, carrying good sulphide ore. The second ore body is about 18in. in width, composed of ironstone carrying some carbonate ore.

Rule & Benjamin have a property to the east of the Myrtleford, and small parcels sent away for treatment gave 17.20 per cent. copper.

Last Adventure (to the south of the West River).—Two distinct well-defined parallel lodes are said to run through the property, and a cross course is visible at the south end; this cross course has been opened up for a few feet and shows about 18in. of ironstone formation carrying an average value of 8 per cent. copper. Of the two main lodes the western has been opened up for about 20ft. in depth and consists of about 5ft. of formation carrying about 16 per cent. copper, mostly as carbonate; the second lode is about 30ft. further east, and where opened up is about 4½ft. in width, carrying bunches of ore containing 25 per cent. copper.

Ravensthorpe Gold and Copper Mine.—On this lease there is a small quartz and ironstone lode running a little to the east of north. This contains small bunches of ore consisting of oxide and carbonates of copper in a gangue of oxide of iron.

The total returns from the leases at the West River up to the end of 1906 are 14.50 tons of ore, of a total value of £189.

JERRAMONGUP.

Copper ore is reported as having been obtained from this locality.

MIDDLE MT. BARREN.

Copper ore is reported to have been obtained here but no particulars are available.

The following tables show the result of assays made in the Departmental Laboratory during the past few years of samples of ore from the Phillips River District:—

TABLE I.

No.	Locality of Sample.	Copper, per cent.	Silver, per ton.		Gold, per ton.	
			ozs.	dwts.	dwts.	grs.
2227	Kingsmill and Martin, No. 1	30·48	0	19	7	7
2228	Do. do. No. 2	27·26	1	9	3	6
2229	Do. do. No. 3	27·72	2	10	1	15
2230	Do. do. No. 4	42·97	0	3	1	15
2231	Mt. Cattlin...	38·43	5	17	4	0
2232	Dr. Jameson	24·60	5	9	0	19
2233	Allan Bros., Oxides	26·18	2	2	0	19
2234	Do. Clean Sulphides	26·18	1	6	Trace	
2235	Kingston, Oxides	32·70	1	9	9	19
2236	Garritty and Filewood, Main Lode ...	26·48	1	19	6	12
2237	Do. do. Spur off Main Lode	33·10	0	6	0	19
2238	Do. do. North Lode ...	38·73	2	5	1	15
2239	Do. do. Heavy Sulphide	1·98	0	19	Trace	
2240	Garritty and Hammond	33·49	2	9	Trace	
2241	Allan Bros., Sulphides	...	*Nil*		Trace	
2242	Ravensthorpe Mine	...	*Nil*		3	12
2243	Dunn Bros.	...	*Nil*		*Nil*	
2390	Floater Mine, Typical Quartz	*Nil*	1	3	387	2

TABLE II.

Table of Analyses made in the Geological Survey Laboratory in 1903 of samples of Copper Ore from the Phillips River District.

Name of Lease and No.	Class of Ore.	Gold.	Silver.	Copper.	Iron.	Lime CaO.	Magnesia MgO.	Alumina Al_2O_3	Silica SiO_2.	Sulphur.
		ozs. per ton.		Parts per hundred.						
Red, White, and Blue, 60 ...	Tailings	0·26	0·28	1·57	22·1	0·5	1·0	4·20	58·4	0·2
Do. do. ...	Concentrates	1·30	0·89	1·80	49·4	*Nil*	Trace	0·1	15·1	0·2
Harbour View, 52	Tailings	0·32	0·28	2·74	15·4	Trace	1·0	4·0	61·2	0·2
Do.	Concentrates	2·65	0·61	12·54	26·4	*Nil*	Trace	1·8	28·1	0·2
Mount Stennett, 108	Siliceous seconds ...	0·32	Trace	8·11	8·8	0·4	Trace	1·6	68·3	Trace
Do.	Picked ore	0·32	1·55	20·54	33·3	0·3	Trace	0·9	9·1	0·1
Elverdton South, 106	Ore	0·12	Trace	37·16	3·9	Trace	Trace	2·9	28·3	0·8
Elverdton, 95	Picked ore	0·12	0·49	31·04	17·7	0·1	Trace	0·8	13·3	0·2
Do.	Seconds	0·65	1·14	12·78	7·4	0·2	Trace	1·8	61·3	2·6
Mount Desmond, 109	Ore	0·32	2·36	30·97	19·0	0·1	Trace	1·0	11·8	0·4
Last Chance, 116	Ore	0·24	1·38	17·64	18·9	3·7	4·1	1·0	24·7	4·4
Kingston, 143	Ore	1·18	1·10	12·46	6·3	...	...	...	(66·7)*	...
Mary, 7	Pyrites from shaft ...	0·08	1·55	21·16	29·7	*Nil*	0·2	0·5	8·6	33·9
Do.	Oxidised ore	0·16	1·14	23·91	32·5	*Nil*	0·2	Trace	5·6	7·6
Mount Cattlin, 15	Sulphide ore	0·28	1·71	16·93	29·5	*Nil*	Trace	0·9	10·5	34·7
Grimsby, 110	Sulphide ore	0·16	0·90	18·58	21·9	0·4	0·7	3·8	25·5	25·4
Do.	Do.	0·08	2·53	10·90	...	...	...	...	...	...

* Total insoluble matter.

The following is a list of the leases in the Phillips River District which have produced copper ore during the last few years, but of which no official particulars are available:—

Centre.	Name and number of Lease.	Tons of Ore.	Value.
			£
Kundip...	Alice Mary G.M.L. 99...	8·02	85
Do.	Christmas Gift 184	29·40	226
Do.	Harbour View North 81	1·55	28
Do.	Afric 197	6·02	39
Do.	Hecla 206	18·86	246
Do.	Lone Star 242	3·90	40 ?
Do.	Australia 149	16·48	168
Do.	Mt. Pleasant 180	3·92	30
Mt. Desmond	Addie 232	5·13	(1·01 tons copper)
Do.	Blue Spec 238	11·83	(1·48 tons copper)
Do.	C.D.C. 186	36·50	282
Do.	Fairlie 266	·84	13
Do.	Resurrection 234	1·10	7
Do.	O.K.	6·67	50
Do.	Winter and Love P.A. 33	8·38	192
Do.	Sundry Leases	21·30	177
Do.	British Flag 174	26·78	249
Do.	Desmond 185	14·16	134
Do.	Mt. Garrity 173	15·01	165
Do.	Rio Tinto 158	6·50	59
Do.	Welcome Stranger 169	12·77	92
Do.	Marnoo 104	4·25	58
Do.	Mountain View 107	9·50	194
Do.	Voided Leases...	4·00	55
Ravensthorpe	Ballarat 205 (and 124)...	54·81	(7·64 tons copper)
Do.	Birthday 215	6·28	45
Do.	Contest 196	5·12	29
Do.	Grafter 202	8·79	(·57 tons copper)
Do.	Last Chance Extended 227	2·55	(·34 tons copper)
Do.	New Moon 204	23·71	(2·53 tons copper)
Do.	Puzzler 219	12·44	94
Do.	Who Can Tell 221	1·45	(·16 tons copper)
Do.	Copper Horseshoe 187...	18·55	100
Do.	Blue Ribbon 176	11·35	88
Do.	Duke of York 177	1·81	6
Do.	Puzzle 189	32·94	235
Do.	Turn of the Tide 166	4·21	13
Do.	Nil Desperandum 139...	4·26	17
Do.	Zealandia 46	58·86	538
Do.	Sundry Claims	56·52	373
Do.	Voided Leases	64·19	356
West River	Sundry Claims	14·50	189

The following table shows the total amount of copper ore reported to the Mines Department since 1899, and to the end of 1906.

(Previous to 1899 there are no official returns given beyond those of the Customs Department, showing the quantity of ore entered for export) :—

Period.	COPPER ORE.									
	Day Dawn D.		Menzies D.		Mt. Morgans D.		Nunnine D.		Northampton Mf.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	tons.	£	tons.	£	tons.	£	tons.	£	tons.	£
Previous to 1899	...	...		...	...		...	...	8,762·78	138,471
1899	...	...	...	...	273·00	4,288	..	...	136·00	2,122
1900	5·15	91	...	...	4,539·00	30,718	...	...	.	...
1901	10·50	76	...	..	7,660·00	40,788	...	...	88·50	277
1902	...	...	...	...	1,954·00	6,852	...	...	...	...
1903	...	...	...	...	18,965·00	45,557	...	...	...	...
1904	...	...	...	...	500·00	900	.	...	...	...
1905	...	...	...	...	60·00	674	..	.	...	...
1906	...	...	4·70	33	4,361·05	21,934	183·50	2,816	...	...
Total	15·65	167	4·70	33	38,312·05	151,711	183·50	2,816	8,987·28	140,870

Period.	COPPER ORE—*continued.*								COPPER ORE.	
	Phillips River Gf.		West Pilbarra Gf.		Yalgoo Goldfield.		State Generally.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	tons.	£	tons.	£	tons.	£	tons.	£	tons.	£
Previous to 1899	...	...	7,018·00	55,270	...	...	...	...	15,780·78	193,741
1899	...	...	2,553·00	29,478	...	..	.	...	2,964·00	35,888
1900	34·00	725	1,605·00	12,139	...	...	...	...	6,183·15	43,673
1901	1,089·14	12,918	1,164·00	15,891	...	..	...	...	9,960·14	69,900
1902	308·25	1,238	...	...	...	...	...	...	2,262·25	8,090
1903	1,561·33	10,984	...	...	...	...	..	...	20,526·33	56,541
1904	3,468·89	24,280	...	...	...	...	..	...	3,968·89	25,180
1905	2,329·04	15,592	..	...	...	...		..	2,389·04	16,266
1906	2,885·00	25,270	...		31·91	91	13·50	193	7,479·66	50,337
Total	11,675·65	91,007	12,340·00	112,778	31·91	91	13·50	193	71,464·19	499,666

TIN.

The only ore of tin which has been worked in the State is cassiterite, of which the following is a brief description :—

Cassiterite (Tinstone, Black tin, Stream tin, Lode tin).—Oxide of tin, SnO_2. Metallic tin, 68 to 78 per cent. Crystallised, massive, or in rolled grains. Black, blue-black, brown, red, or grey; translucent to opaque. Hard (6 to 7), brittle. G., 7.0.

Tin oxide is, however, also a constituent of several well-defined mineral species which constitute ores of tantalum, q.v. p. 106. The amount present in these is, however, small and unimportant commercially, varying from a mere trace up to at most two per cent.

Tin ore has been smelted from several localities in the State, viz. :—

Moolyella, Cooglegong, Old Shaw (Eley's Well), Green's Well (Mt. York, Chingamong), Wodgina, Stannum, Mill's Find, (North-West) ; Greenbushes, Nannup (Smithfield), (South-West).

Further, tin ore has been reported to occur in greater or less quantities in river sands at—

Division of the State.	Centre.	Nature of Occurrence.
Kimberley ...	Head of Bow River ...	Stanniferous black sand.
Do. ...	Head of Lennard River ...	do.
North-West ...	Mt. Francisco	Detrital cassiterite.
Do. ...	Thomas River	Stream cassiterite.
South-West ...	Brookton	do.
Do. ...	Darkan	do.
Do. ...	Gordon River	do.

Most of these reported discoveries lack confirmation.

The discovery of tin at Greenbushes was the direct outcome of an official inspection of the Blackwood District by Mr. E. T. Hardman, then Government Geologist. During this trip he was accompanied by a Mr. D. W. Stinton, to whom Mr. Hardman suggested the probable occurrence of tin ore in the locality. Mr. Stinton's subsequent searches for that mineral were rewarded in 1888 by the discovery of a rich lead of stream tin ore in Bunbury Gully, near the site of the present State Battery at the south end of the Greenbushes field. A large number of leases were taken up, but in the absence of any labour conditions, were for some time held speculatively, and but little done to develop the deposits. By 1891, however, mining was being vigorously prosecuted, for in that year the output of the field amounted to 204 tons of concentrates.

The discovery of gold in many parts of the Pilbara field in 1888 and 1889 led to vigorous prospecting of the whole of this part of the State, with the result that tin ore was detected in many of the streams lying between the Yule and Coongan Rivers. The most important, at the time, of these discoveries was that of the Old Shaw, or Eley's Well. Several causes operated against the working of these deposits at the time, viz: the ease with which alluvial gold was to be obtained in the district, the restriction of the size of a tin claim within a goldfield to that of a gold claim, and finally the great cost of transporting the ore to the coast and thence to the tin smelters at Singapore or Sydney. These difficulties were subsequently overcome, and in 1893 over 56 tons of black tin were raised at Eley's and exported.

No further localities were opened up till April of 1899, when extensive alluvial deposits were first worked at Moolyella. In August, 1900, payable stream tin was located at Cooglegong Creek, and in 1902, lode and stream tin at Stannum, and subsequently at Wodgina. In 1905, tin was discovered at Green's Well, and in 1907 at Nannup (Smithfield), to the south of Greenbushes.

Description of Tin Fields and Mines.

MOOLYELLA.

This field was geologically mapped and reported upon by the Government Geologist in 1904. The results of his investigations appeared in Bulletin No. 15 of this Department, and from it the greater part of the following description has been taken :—

The tinfield occupies some rugged granite hills lying at the heads of several small tributaries of the Coongan River, and near the centre of a mass of intrusive granite about 30 miles square. No definite age can yet be assigned to this rock. At Moolyella it is traversed by several north and south quartz reefs, and by numerous pegmatite veins parallel to them. It is the latter which are the original matrices of the tin ore. These pegmatites consist very largely of albite, but contain also quartz with minor amounts of garnet and muscovite. A typical piece devoid of cassiterite had the following composition :—

	[5397]
SiO_2	68·86
TiO_2	·07
H_2O combined	·03
K_2O	·07
Na_2O	10·22
CaO	39
MgO	·54
FeO	1·15
Al_2O_3	18·74
H_2O hygroscopic	*Nil*
MnO	·45
	100·02

These pegmatite "lodes" have only been worked to a very slight extent for tin, so that no judgment can be formed of the percentage of metal contained in them, nor is their neglect an evidence of extreme poverty, since the field is entirely without crushing facilities, and alluvial ore is still abundant. Such deposits too are evidently due to deep-seated causes, and in all probability extend to great depths. The tin in them is mostly coarse-grained.

A large quantity of residual tin ore, derived from the decomposition *in situ* of the tin-bearing pegmatites, occurs all over the field. This form of ore is very ragged and angular [5403]. Some very good prospects were obtained by Mr. Talbot, the Field Assistant, by dryblowing the surface *debris* along the face of an almost horizontal pegmatite vein occurring about 16 chains west of the Independent, M.L. 45. Careful search along the outcrop of the vein resulted in finding tin in the rock itself.

Almost the whole of the ore exported from this field has been derived from the alluvial deposits. No buried leads indicating a past system of drainage radically different from the present have been located. All the alluvial ore has been won from comparatively shallow deposits formed in the existing valleys of Moolyella, Meagher, and Prospectors' Creeks, and their numerous small tributaries. These deposits, though nowhere very deep, reach in places a width of more than 10 chains.

"Moolyella Creek is the most important yet worked in the district, and drains the largest area of country. For about two miles and a half of its course, the creek has been held at one time or another under mineral lease, but at the present time these have all been abandoned."[*] Moolyella Creek is formed by the junction of the waters of Swan Gully, Universal Gully, and Tin Gully.

Swan Gully rises in the very high and rugged country embraced within the area once held as Victoria, M.L. 6. It runs in a general north and north-east direction until it opens into Moolyella Creek. The whole of the country drained by it is of granite, intersected by numerous pegmatite veins, none of which appear to have been worked. The alluvial deposits are only 18in. to 2ft. in thickness in the upper portion of the creek, but this increases as the channel is followed down. The watershed of this creek embraced six leases, and must have yielded a considerable amount of ore. Separate records, however, could only be kept of the output during the actual tenure of the leases. These records show the following totals to date :—

			£
Victoria, M.L. 6	1899 ...	1·50 tons ...	113
Swan, M.L. 5	1899, 1900...	26·00 ,, ...	1,717
Lady Vosper, M.L. 13 ...	1900 ...	32·15 ,, .	1,862
Mandalay, M.L. 11 ...	1900 ...	1·10 ,, ...	71

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[*] Geological Survey Bulletin 15. Perth: By Authority, 1904.

All Nations, M.L. 7, and All Nations Extended, M.L. 9, were early absorbed into a large lease (M.L. 22) embracing the heads of Moolyella, Meagher's, and Prospectors' Creeks. It was owned by the Marble Bar Tin Syndicate, included M.Ls. 2, 3, 7, 9, 4, 8, and 14, and yielded in 1899-1901, 42.25 tons of ore, valued at £2,962. The area embraced by the old M.L. 9 has recently been repegged, and is held as M.L. 130.

Universal and Tin Gullies pass through similar country to Swan Gully, viz. : granite, intersected by pegmatitic veins. They traverse M.Ls. 18, 31, 15, 10, 28, and 12, all of which have been abandoned since 1900. Like Swan Gully, they have yielded a large amount of alluvial ore, of which a separate record has only been kept of a very small proportion. At one point on M.L. 15, a pegmatite vein about three feet in thickness crosses the bed of the stream and forms a low ledge in the channel over which the water drops about three or four feet when the stream runs. About nine tons of black tin were obtained from a pocket just below the fall. The total recorded output of leases in these gullies is :—

Universal, M.Ls. 10, 12, 15, 18, 31, 1899-1900—51.70 tons, £4,380.

Moolyella Creek, below the confluence of the three previously-described gullies, has yielded alluvial tin for some miles along its course down to its junction with Brockman's Creek.

It traversed M.Ls. 33, 25, 23, 21, 20, and 29, all now abandoned. To the east of the Government Well (on M.L. 25) is an almost flat vein of pegmatite about three feet in thickness, trending north and south, and apparently continuous with that observed in M.Ls. 12, 10, and 15. In 1903 a vertical shaft had been sunk 15ft. on M.L. 23 (The A 1). It bottomed on granite of the usual type after passing through 10ft. 6in. of alluvium. A good deal of water was obtained from this shaft, which was used for puddling. The average depth of made ground in Moolyella Creek for about a mile below this is 8ft., and the width of stanniferous wash varies from 15ft. to 60ft. The records of leases on this creek give the following returns :—

O.K. Group, M.Ls. 20, 21, 23, 1899, 1901—103.00 tons, £6,033.
Three Jacks, M.L. 29, 1900—2.25 tons, £158.

Brockman's Creek, for about a mile and a half above and below the junction of Moolyella Creek, is now held as Dredging Claim No. 1, which should shortly be on the list of producers.

Meagher's Gully lies between Moolyella Creek and Prospectors' Creek, and has been extensively worked for alluvial ore. The gully starts to the north of M.L. 3, and runs northward for about half a mile along the west side of an outcropping pegmatite vein. It is from this and other similar veins that the ore has doubtless been derived. After passing through M.Ls. 4 and 8 it bends sharply to the west, and continues in that direction through M.Ls. 14, 16, 43, and 44, and beyond again. All these leases are now voided. M.Ls. 4, 8, and 14 formed part of the property held by the Marble Bar Tin Syndicate. On Old Sportsman, M.L. 46 (once Sportsman, M.L. 16), the tin wash is about 18in. in thickness, of which 8in. or 10in. appear to be payable. A thickness of three feet of wash is exceptional. The width of alluvium in the lower portions of the gully is as much as 10 chains, though the thickness nowhere exceeds 8ft. to 10ft. The recorded output of leases in this gully other than those of the Marble Bar Syndicate's property are :—

Old Sportsman, M.L. 46, 1899-1901—21.10 tons, £1,195.
Huntsman Group, M.Ls. 43, 44, 1900-02—32.50 tons, £1,827.

Prospectors' Creek rises close to the heads of Meagher's and Moolyella Creeks, and flows in a general north-westerly direction through A.C. 6 and the now-abandoned M.Ls. 3, 2, 61, 60, and 45. In its upper portion it flows through rugged hills, and throughout passes over granite rocks seamed with quartz and pegmatite veins. On England, M.L. 2, is the outcrop of the tin-bearing pegmatite whose composition is given on page 50. This vein is in a fine-grained mica granite, and is about two feet thick, and contains coarse and fine tin ore, some fragments reaching nearly an inch in length. It has been opened up to a depth of 4ft. for a distance of 30ft., this being the only instance in which a tin lode has been worked on this field. About 40 tons of tinstone were obtained from a pocket on the creek adjoining the vein. Lower down the creek on Juanita, M.L. 61, a considerable amount of ore was obtained on the upper side of a quartz bar. The Independent, M.L. 45, still further down, has yielded, according to records, 15 tons of ore, valued at £922, all produced in 1900. About one mile in length of Prospectors' Gully is now held as A.C. 6, which, during 1906 yielded 127.25 tons of black tin, valued at £14,242 ; during 1905 yielded 95.55 tons, valued at £6,876 ; 1904, 5.05, valued at £330.

The alluvial at the head of Prospectors' Gully is very shallow, whilst lower down it reaches as much as 16ft. in depth. The stanniferous lead varies from 3ft. to 12ft. in width.

Five miles east of Universal Gully is a new lease, M.L. 131, which has not yet entered the list of producers.

The lode cassiterite from Moolyella is quite black in colour, and is associated so far as known at present with quartz, albite, a very pale pink garnet, and muscovite. The alluvial ore is black, or brownish-black, and is associated with quartz, clay, orthoclase, albite, very pale garnet, monazite, manganotantalite, and mangano-columbite. On the whole the dressed ore is very pure. An early sample from Prospectors' Creek gave 68.1 per cent tin by dry cyanide assay.

Statistics show that the Moolyella Tinfield has yielded, up to the end of 1906, 1,705.19 tons of black tin, valued at £138,562. As the whole of the alluvial tin raised during the first year or two of the field's history was not reported to the Mines Department, these figures are probably slightly under the actual output of the field. A more detailed statement of the output will be found in the table on page 76. With the exception of a negligible amount of lode tin raised on England, M.L. 2, the whole of this ore has been derived from shallow alluvial deposits of recent geological age. Such deposits must now be largely depleted, but there is strong evidence to show that tin lodes are numerous in the district, and in at least one instance should be well worth crushing. Doubtless with the arrival of the railway at Marble Bar only 10 miles distant, a new era of lode mining will be inaugurated and a long and prosperous future assured to the field. At the end of 1906 the total number of miners on the field was 400.

ELEY'S OR OLD SHAW TINFIELD.

This now deserted centre lies in the watershed of the Shaw River, immediately to the east of Black Range. Though one of the first tinfields discovered in the State no detailed description of it has ever been made. From the geological map of the Pilbara Goldfield published in 1906, it is seen that this field lies within an area of granite cut by a large intrusion of a basic rock which forms the backbone of the Black Range.

Only four mineral leases have ever been held at this locality. Of these, three, M.Ls. 39, 40, and 42, constituting the Singapore group yielded in 1899 and 1900, 6.75 tons of black tin, valued at £424. None of these leases are now in existence. Altogether 220.79 tons of black tin, valued at £10,530, have been raised, all of which has apparently been of shallow alluvial origin. During 1906 no ore whatever was raised.

A sample of stream ore [5185] from Farwig's Claim in the Departmental Museum, is mostly very fine grained and angular. A fire assay of it gave 70.1 per cent. metallic tin. With the black cassiterite are associated numerous small grains of brown monazite.

In the Perth Museum there is a fine sample of coarse angular and partly crystallised euxenite, said to be from Eley's. Other observers have noted this rare mineral as coming from the alluvial tin ore of the "Marble Bar District," a term which officially includes the Moolyella, Eley's and Cooglegong fields.

COOGLEGONG.

This field also is situated upon a tributary of the Shaw River, a little to the east of White Quartz Hill, and about 10 miles northwest of Eley's. It has been described by the Government Geologist visited it in 1905. It lies close to the western boundary of the granite mass which includes Eley's, the country to the west being occupied by greenstone schists. The granite of Cooglegong is a micaceous variety which in some places is gneissic, and is intersected by numerous veins of pegmatite "which have doubtless been the original source from which the stream and residual tin has been derived. All the tin hitherto obtained from the district," viz., 907.44 tons of ore, valued at £68,463, "has been derived from the alluvial deposits which have been formed in the existing valleys. So far as has at present been observed, these alluvial deposits do not attain any very great thickness, although their width must in many cases be very great."* In addition to the true alluvial deposits, there occurs a fairly large quantity of residual tin ore along the decomposed outcrops of the pegmatite veins.

Some specimens of albite pegmatite recently brought to Perth by the State Mining Engineer carry a considerable portion of tinstone, though neither of the two specimens of pegmatite in the Departmental collection appear to carry tin ore. One [2027] is composed largely of gadolinite, with quartz and albite; the other of garnet, albite, and quartz. Monazite also is reported on good authority to have been found in these pegmatites. A sample [2026] of alluvial ore is somewhat coarse in grain and very angular, well-defined crystal faces being plentiful. In addition this sample carries many fragments of monazite and one or two pieces of euxenite. A second sample of stanniferous gravel, almost equally coarse in grain collected by Mr. Talbot carries black cassiterite with notable amounts of monazite and garnet besides some magnetite, quartz, and felspar.

At the end of 1906 there were 80 men prospecting and working alluvial on this field.

GREEN'S WELL.

This locality is variously known as Green's Well, Mt. York, or Chingamong. Its exact position has not been fixed by survey, but it is described as lying 20 miles E.N.E. of Wodgina in about lat. 21 S. and long. 119E. It would appear therefore to be on the eastern boundary of that area of granite which includes Wodgina. Several leases have been taken up on this field, viz., those numbered 104, 105, 111, 112, 113, 114, and 115. Of these the first and two last are abandoned, leaving four still in force. This field was originally prospected for tantalum, and though tin occurs with the rarer metal no output of either has ever been reported to the Mines Department.

A report of the Acting-Inspector of Mines in January, 1906, described the only tin workings in existence at that time in the following terms:—

"Several tin lodes have been pegged out in this locality, but little if any work has been done on them." Tantalite was being obtained from a decomposed pegmatite dyke and from alluvial ground. A sample of dressed tin and tantalum ore [6503] from Green's Well presented to the Department by Mr. William Walsh assayed—metallic tin, 15.62 per cent.; tantalic oxide, 42.39 per cent. This was coarse-grained ore mostly waterworn.

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*Geological Survey, Bulletin 23. Perth: By Authority: 1906. Page 74.

WODGINA.

This field is situated at the north-east end of a rough greenstone range rising from an extensive granite plain to the east of the Yule River. It was visited by the Government Geologist in 1905, and very completely described in Bulletin 23 of this Department. From this the following description has been taken:—

The north-western portion of the field is occupied by hornblende rocks, largely schistose, whilst to the south-east lies the large area of granite composed of quartz, felspar, and mica (mainly muscovite). Between these two main rock masses and occupying a strip of country from half-a-mile to a mile wide, there are a series of schists mostly very siliceous and carrying either mica or hematite. These schists are of indeterminate origin, are very much folded and faulted, and on the whole have a prevailing dip to the west. They occupy with the greenstones a very rugged range which rises to a considerable height above the level of the surrounding plains.

For some distance from the boundary of the granite the schists and greenstones are penetrated by pegmatite veins. These are of considerable economic importance as they are the primary source of the tin and tantalum ores. Unlike other tinfields in the State, Wodgina has yielded less alluvial ore than lode ore taken from pegmatite veins within the schist area. Here they have a rough parallelism running north-east, parallel to the lines of foliation, though some few run north-west. They seem to be offshoots off the main granite mass. They are very irregular both in width and underlie, and some are more persistent in strike than others. They vary from mere threads to veins over 500ft. in width, and are made up of two or more of the following minerals, viz., quartz, muscovite, lepidolite, orthoclase, albite, tourmaline, cassiterite, and tantalite.

"In the vicinity of and along the margins of many of these dykes are bands or bunches of tourmaline. In some cases these occur only on one side of the dyke, constituting as it were a marginal zone either in the dyke or in the adjacent country rock. In others the dykes consist largely of quartz crowded with tourmaline to such an extent at times as to constitute fully one-third of the entire rock."

"The tin ore appears to be an original constituent of the veins; it is, however, so far as observations have at present been carried, concentrated along certain lines in these dykes, and does not appear to be generally disseminated in minute quantities in the pegmatite. The tin occurs in all shapes from minute grains up to pieces weighing as much as 50 or 60lbs." The cassiterite of both lodes and streams varies from a black opaque mineral to one that is pale grey and semi-transparent.

Alluvial tin ore has been obtained from all the gullies and watercourses over an area of about two miles by one. There is however only a very limited area of detrital deposits in the gullies and ravines, and such are only narrow and in no case of any depth. McCarthy's Creek, Outside Creek, and Two-Mile Creek with their tributaries have all been somewhat extensively worked, yielding by dryblowing rather coarse tin mixed with more or less tantalite. One piece of tinstone with tourmaline [6271] from Ogilvie's Gully now in the Departmental Museum weighs 43lbs., whilst a second fragment [6272] of a large crystal weighs 28lbs. Detrital ore has also been obtained from the surface at the outcrops of the numerous pegmatite veins from which it has been shed.

Both detrital and lode ore is sometimes black in colour and sometimes dark or pale brown to almost colourless. A sample of stream ore [6346] of a very pale to medium tint gave 74.0 per cent. tin by fire assay. A second sample [6345] of dryblown ore consisting of tinstone and tantalite coated with brown dust yielded 50.35 per cent. metallic tin, with 20.85 per cent. of combined tantalic and niobic oxides.

At present 26 leases are in existence at Wodgina, of which at least four are held as tantalum leases and produce no tin ore. Of the remaining 22 only five produced ore during the year 1906, viz., M.L. 84, Mt. Cassiterite; M.L. 85, Commonwealth; M.L. 88, Chamberlain; M.L. 89, Tinstone; and 93, Mt. Cassiterite North. In addition there was an output of 3cwt. from Q.C. 7.

Cassiterite, M.L. 84.—This is the premier mine at Wodgina proper, both in point of age and output. The ground was originally taken up by Messrs. A. G. McCarthy and D. Ogilvie in 1902. From that time up to the end of 1906, it has produced 37.27 tons of black tin, valued at £3,810. Practically the whole of this was taken from lodes.

The lease occupies the highest portion of the range and is drained by the tributaries of McCarthy's Creek, from one of which, Ogilvie's Gully, a considerable quantity of detrital tin has been obtained. The greater part of the surface of the lease is occupied by flaggy quartzites and ferruginous slates of the type common to the district. In the south-west portions of the lease these give place to greenstones. A conspicuous feature in the geology of the lease is the large number of pegmatite veins which intersect it in a general north-east direction. Owing to the small angle of dip these at times present a very extensive outcrop.

Mining operations have been principally confined to what is known as the main lode, which is situated on the highest portion of the ground on the northern boundary of the lease, across which it passes into M.L. 93, extending altogether for some distance across the surface in a north-east direction. This lode which in places contains veins of grey tin, at least 1in. to 1½in. thick [6463] can be traced from the creek which crosses the northern boundary of the lease up the side of the hill in the direction of the main shaft. An opening 80ft. from the creek shows it to be 4in. wide at the surface, but 2ft. 8in. at the bottom. Very coarse angular tin occurs in the lode along the outcrop. The main shaft was sunk a little to the south of the outcrop of the lode which was tapped by a crosscut at 50ft. Here the lode was 8ft. or 9ft. thick, very micaceous and showing coarse grey tin ore on either wall.

A small wedge-shaped vein carrying cassiterite, tourmaline, and mica was opened up 500ft. south of the main shaft. Another opencut about 200ft. north-west of the main shaft disclosed a flat pegmatite vein with a little tin ore along the footwall. At one point on the latter there is a large cross course about 4ft. thick made up of tin, tourmaline, and mica.

Some work has also been done near the south-west corner of the lease where pegmatites carrying a little coarse tin have been located in an opencut, and again at a shallow depth in a shaft.

Stream tin has been obtained from the portion of Ogilvie's Gully lying within this lease.

Mt. Cassiterite North, M.L. 93.—This lease lies immediately to the north of the last named, from which the main lode passes into it. Similar geological conditions prevail here but no details of the workings are available. To the end of 1906 the lease produced 6.12 tons of lode tinstone, valued at £643.

Commonwealth, M.L. 85.—This lease adjoins the Cassiterite on the south. A small triangular patch of greenstone occupies the north-west angle, whilst the rest is taken up with quartzites crossed by pegmatite veins. An opencut has been put in along the face of a pegmatite dyke 6ft. thick which underlies at a low angle to the west. The under surface of the dyke contains a foot or two of a mica and tourmaline rock which carries tin, many large crystals of which may be seen in it. The total output of dressed ore from this lease is 2.95 tons, valued at £348.

Tinstone, M.L. 89.—This adjoins the Commonwealth M.L. on the east. It lies in the heart of the main range, and is drained by the two important tributaries of the Two-Mile Creek. A steep ravine in which the northern branch flows has been worked in a more or less desultory fashion for the detrital tin it contains. The lease is occupied by typical iron-bearing quartzites, intersected by six distinct pegmatite dykes. One of these, which passes into M.L. 85, is composed mainly of quartz and lepidolite, with a little albite [6454].

The most southerly working on the property is an opencut near the western extremity of a pegmatite dyke 2ft. thick, which continues round the slope of the hill to a point above the mouth of the main tunnel. It underlies in the opencut at an angle of 35 degrees to the north-west, and on the footwall carries a narrow vein of almost solid crystalline tourmaline, with which is associated a little quartz, mica, and tinstone. In the main tunnel a similar condition prevails, viz.: a pegmatite vein, 2ft. 6in. wide, with, in this case, stanniferous veins of tourmaline and mica on both walls. An opencut on this vein some few feet farther west disclosed coarse tinstone associated with tourmaline.

Up to the end of 1906 this lease yielded 3.60 tons of tinstone, valued at £360.

Chamberlain, M.L. 88.—This lies half a mile due south of the Commonwealth, M.L. 85, and has produced 35 tons of lode tin, valued at £60. The tin lode on this ground was discovered by tracing the ore found in the creek up the side of the hill to the present workings. The lease is in high ground, occupied by iron-bearing quartzites, hornblende schists, and mica schists, traversed by pegmatite dykes. Operations have been confined to a narrow S-shaped dyke cut by two vertical faults. In an opencut near the northern boundary there is exposed a total thickness of 8ft. of rock, comprising a band of quartz three feet wide, with from 12in. to 18in. of yellow clayey rock, probably representing the felspathic portion of the dyke, and carrying some tin ore. Farther to the east the weathered pegmatite is about five feet thick, and carries coarse angular tin ore. A very good pocket of ore is said to have been obtained in this cut. Such pockets would appear to be associated with faults at the point of their intersection of the lodes.

In addition to the above-described leases, Quartz Claim No. 7 produced during 1906 a total of 0.15 tons of lode tin, valued at £18. Of other leases now held but not yet reporting any output of ore to the Department, the following few particulars are available:—

M.L. 110, immediately north of M.L. 93. The creek has been worked for stream ore, whilst lode tin occurs in a micaceous dyke.

M.L. 133 (late M.L. 94) adjoins northern boundaries of M.Ls. 84 and 127. Detrital tin has been obtained from two creeks. Ore has been located by tunnelling in a lode about three feet thick, composed largely of muscovite and tourmaline.

M.L. 117 lies immediately west of M.L.s. 84 and 93. An opencut disclosed a dyke 40ft. to 50ft. wide, and composed of quartz, orthoclase, and albite. Coarse tin occurs along both walls of the dyke, and a little shows in the mass of the dyke itself, which passes to the south into M.L. 84. Some tons of tin ore were said to have been obtained from this opencut by an early prospector.

The total output of ore from Wodgina proper cannot be stated, as the official records include with it ore obtained from Stannum and Mill's Find. The total output of the entire district up to the end of 1906 has been 77.09 tons of black tin, valued at £7,494.

STANNUM.

Stannum, or Eastern Creek, lies about eight miles south of Wodgina, on the same range, and was the scene of the first tin discovery in this part of the country.

The geological structure of this field is similar to that of Wodgina. Granite plains occupy both sides of the range, which is itself composed of greenstones and greenstone schists with associated ferruginous quartzites, etc. The greenstones have been penetrated by a large intrusion of a typical acid porphyry, and later still both porphyry and greenstones have been cut by pegmatite dykes.

Of the two leases taken up at Stannum only one, viz. : M.L. 77 has, according to official data, yielded any tin ore.

The total output of the locality is submerged in that of Wodgina.

Stannum, M.L. 77.—About two-thirds of this lease is occupied by greenstone schists, the remainder by intrusive porphyry, whilst a large pegmatite dyke with several branches passes through the lease from north to south. One of the branches has been followed down from the surface, and also cut in a vertical shaft. The second branch in the lease is a foot thick where it has been opened up, and shows tin in the faces. The main dyke has also been worked. It is a foot thick at this point, and contains coarse tin ore. It is composed largely of quartz and tinstone, with a little albite and mica. A large alluvial flat in the north-west corner of the lease has been stripped to a depth of 3ft. or 4ft., and a large quantity of clean angular tin ore obtained from it.

The total output of this lease up to the end of 1906 is 6.10 tons, valued at £461.

On M.Ls. 79 (Stannum North) and 80 (Comet) tin-bearing dykes of the usual type have been located, but neither lease is credited with any output of ore. The lack of crushing facilities in the district is doubtless responsible for this.

MILLS FIND.

This small field lies about six miles south-east of Stannum, on the same line of country. Some stream and lode tin recovered from M.L. 112, Bright Star, and other ground, is included in the returns from Wodgina.

GREENBUSHES.

This is the oldest and most important tinfield in the State, having been responsible up to the end of 1906 for a total output in 18 years of 5,585.70 tons of black tin, valued at £367,605. It is situated in the Blackwood Ranges, in the extreme south-west corner of the State, where the abundant supply of timber and water are of great value in mining and ore dressing.

The geological structure of the field is as follows:—The tops and slopes of the ridges are covered by a thin compact capping of laterite, consisting of a mixture of bauxite and limonite, the former usually predominating. In places a very pure iron ore is found, and has been largely used by the Fremantle Smelting Company as flux. This laterite is due to the concentration at the surface, by capillary upward movement of water solutions, of the alumina and iron oxide leached out from the underlying crystalline rocks. Immediately below the laterite these rocks are represented by clays (leached rock), formed *in situ*, and these gradually pass into the crystalline ground rock. The main mass of the latter is granite, foliated in places, and outcropping in the steep sides of the numerous gullies. It is typically coarse-grained and micaceous. Dykes of greenstone, in places altered to hornblende schist cut through the granite. Two samples of the uncrushed rock, one [7000] from Loc. 991, the other [5198] from Bunbury Gully, are both bronzite-diabases composed of plagioclase, augite, bronzite, hornblende, and ilmenite. The primary ore bodies appear to be either (1), highly foliated bands of granite (shear zones similar in structure and origin to the auriferous greenstone lodes of Kalgoorlie) impregnated with secondary cassiterite, topaz, tourmaline, etc. ; (2), albitic pegmatite veins or dykes ; (3), quartz-tourmaline veins or dykes. Some veins also of these types exist which are not tin-bearing at all.

The secondary ore deposits are of two types (1), Residuary deposits, including laterite and residuary clays and sands, representing rock decomposed *in situ*, and in which angular ore occurs in its original position. These are of minor importance. (2), True alluvial deposits. The swampy flats and narrower stream beds are filled with a very variable thickness of true alluvial material. Sometimes the alluvial ore is buried to a depth of 50ft. or 60ft., and in places is of sufficient age to have become consolidated into a hard conglomerate. Mostly, however, the alluvial is under 20ft. deep, and is composed of loose sand, clay, or low level laterite gravel. It is deposits of this nature that have yielded by far the greater portion of the tin output up to the present. Within the last two years, however, more attention has been paid to the lodes, and each month sees the addition of more mines to the list of those producing lode ore.

The detailed description of the mines is best studied in connection with the drainage system of the district.

Dumpling Gully.—This is the northernmost watershed, and includes an area bounded by lines running roughly south-south-east from the railway station to M.L. 388, east of the township ; thence west to Norilup Brook, which rises at the head of Dumpling Gully at an elevation of about 850ft. The upper part of the Gully is occupied by a wide alluvial slope, passing upwards on either side into laterite. Farther down the valley becomes narrower and steeper, and granite appears on either side of a narrow stretch of alluvium, the former passing under the ubiquitous laterite a little way up the slope. A narrow belt of alluvium bounded by granite appears also in Gibney's Gully, an important tributary of the main gully.

The most northerly workings in Dumpling Gully were within a few chains to the west of the railway station. Here there were 2ft. or 3ft. of laterite (conglomerate) passing down into sand, and this at a shallow depth into granite. The sand has yielded good prospects of angular tin [1281] which must have had a local origin.

M.L. 218, *W.A. Mt. Bischoff* (20 acres).—This lies immediately South of the North Greenbushes township. Specimens of ore [688, 689] from this lease consist of a hard ferruginous conglomerate carrying a considerable amount of fine and coarse sub-angular tinstone. A third specimen [690] appears to be a much weathered granitic rock carrying a little coarse angular tin ore.

Previous to 1905 this lease yielded 188.35 tons of black tin, valued at £11,605. Since that date it has been held by the Westralian Stanneries and the Greenbushes Development Company, and the returns lumped with those from other leases. *See* below, under M.Ls. 295 and 35.*

Claim 671 (4 acres odd).—This lies immediately east of M.L. 218 ; the official records show an output during 1906 of 0.54 tons, £49.

M.L. 394 (154) *North Junction* (20 acres).—Near the westerly corner of this, under 5ft. of laterite, two shafts exposed a coarse micaceous granite carrying tin. During 1906, this lease reported 0.05 tons of stream tin and 0.10 tons of lode tin, of a total value of £17.

M.L. 35, *Horan's* (12 acres) and *M.L.* 169 (20), *Horan's No.* 1 *North* (15 acres).—These are now held by the Greenbushes Development Company, together with M.Ls. 218, 272, 287, 296, 375, 395. They were previously owned by the Westralian Stanneries, and still earlier were independently held. Previous to 1905, M.L. 35 produced 188.35 tons of dressed ore, valued at £11,605.

M.L. 295, *W.A. Mt. Bischoff No.* 2, *Ltd.* (14½ acres approx.)—Now the only lease held by the Westralian Stanneries, Ltd., which once included M.Ls. 1, 35, 169, 218, 221, 228, 272, 287, 292, 295, 299, 310, 347, and 353.

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* *Vide* Introduction, page 16.

M.L. 470, *Little Wonder* (8 acres approx.).—Includes old alluvial claims 760 and 767, and is held by the Nickel-Kramer Tin Mining Co., Ltd. This company holds also M.L. 471 and has already erected or in process of erection, a considerable amount of crushing and concentrating machinery. In addition, they are reported to contemplate the working of much of their property by dredging, having purchased the dredge once used to work the alluvial at Coolgardie. The stanniferous material on M.L. 470 consists of wash and hard ironstone conglomerate. The output during 1906 was 8.36 tons of concentrates, valued at £900.

M.L. 375, *Glasgow* (20 acres), lies a little North of Greenbushes township, and covers part of the ground held previously as M.Ls. 75 and 112. A lode said to be 5ft. wide has been sunk on to a little depth. Of two specimens of lode stuff presented by Warden Geary to the Museum in 1905, one [6517] from near the surface is a pegmatite composed mainly of albite with tourmaline, quartz, muscovite, garnet, and a considerable percentage of tin ore; the other [6518] from a depth of 30 feet is a quartz-tourmaline rock with but little tin. Some very angular ore [2019] collected in 1900 assayed 66.3 per cent. metallic tin. This lease has been reported to yield up to the end of October, 1906, when it became part of the Greenbushes Development Company's property, 1.54 tons of tinstone, valued at £150. Of this, 1.39 tons were obtained from 206 tons of lode stuff.

M.L. 337, *Gladstone* (5 acres), is held in conjunction with *Claim* 706 (2 acres). It includes part of old M.L. 78, and adjoins the township on the north side. Output:—

To end of 1905 ...	24·18 tons ...	£1,912
1906 ...	8·08 „ ...	821
Total	32·21 tons	£2,733

M.L. 296, *Central* (39¾ acres).—Output of ore (alluvial):—

To end of 1905 ...	43·15 tons ...	£3,573
1906 ...	57·01 „ ...	6,155
Total	100·16 tons	£9,728

Claim 726 (2 acres approx.) is almost surrounded by M.L. 296. Output:—

1906	5·81 tons ...	£603

M.L. 400, *Old Sport* (5 acres) adjoins the south-west corner of Recreation Reserve 2687. The output during 1906 was 0.60 tons of lode tin, valued at £60 from 105 tons of lode stuff. In his original report on Greenbushes, the Government Geologist describes this locality as a sandy flat flanked by laterite rises, stanniferous granite much weathered being encountered at a depth of about 12ft.

Locs. 289, 290 (once Bishop Gibney's mine) occupies granitic and alluvial ground at the heads of two tributaries of Dumpling Gully. This property has been a most consistent producer from the earliest days of the field. In 1890 Mr. H. P. Woodward wrote of this property.* "The most extensive workings on this area, and those from which most tin was raised are situated about the middle of the area on the south side of a swamp, where close to an ironstone ridge a gravelly wash carries about ½lb. of tin to the dish. Further into the swamp there is about 6ft. of sand, which carries about 1oz. of fine tin to the dish. . . . . Further to the westward, in a little gully, a gutter about 15ft. wide is being worked by a series of shafts and drives. In the sinking there is from 5ft. to 6ft. of gravel which is cemented above the wash, and here is from 1ft. to 1ft. 6in. in thickness often carrying pieces of ferruginous sandstone very rich in tin, the whole wash yielding close up to 1lb. to the dish."

The rock underlying this ground is a coarse granite.

The total output credited to these two blocks by the Statist to the Mines Department is:—

To end of 1905	...	111·86 tons	...	£9,155
1906	...	108·75 „	...	11,110
Total	...	220·61 „	...	£20,265

This is no doubt considerably short of the real total owing to the fact that the statistics have only been kept in detail for a few years past.

M.L. 361, *Boronia* (20 acres).—This lease is situated at a considerable distance from any other mine, except Claim 727 which adjoins it. It lies about 1½ miles north-west of Loc. 289. Its output has been:—

To end of 1905	...	5·05 tons ..	£406
1906	...	6·37 „ ...	638
Total	...	11·42	£1,044

Many other alluvial claims and leases are held and have been held in Dumpling Gully, but none are credited with any output of ore during 1906, except those described above.

Williams' Claim, which was the most productive of all in the early days, was situated close to the road in the vicinity of Reserve 1929, the wash was from 1ft. to 3ft. thick and was covered by laterite and ferruginous sandstone.

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* Annual General Report for the year 1890, by H. P. Woodward, Government Geologist. Perth: By Authority, 1891.

Spring Gully.—Lies to the south of Dumpling Gully, and like it falls to the west into Norilup Brook on a slope of about 200ft. to the mile. It is, roughly, two miles long and one mile wide, and has from the first been the scène of considerable mining activity, a very large amount of alluvial tin having been found within its boundaries.

The head of the main channel is on Claim 608, at the south-east corner of Loc. 290. After running in a south-west direction for three-quarters of a mile it is joined by a second channel from the south-east, which rises in a large ti-tree or paper-bark swamp lying to the north of M.Ls. 313 and 314. The valley then runs west to Norilup Brook through granite covered on the rises by laterite. About the middle of the Spring Gully Claim an important branch, Mulligans Gully, comes in from the north. Most of the tin in this valley has been won from the main stream, Mulligan's Gully, and the area between the two, which is covered with laterite, at times tin-bearing and covering wash dirt and soft stanniferous granite veins. A little alluvial tin has also been obtained from the southern tributary and the swamp at its head. On the ridge forming the eastern boundary of the gully several well-defined lodes have been located, see accounts of the Dixie and other mines below. It is doubtless from these and from the stanniferous veins in the vicinity of Locs. 289 and 290 that most of the alluvial ore has been derived.

M.L. 471, *Mt. Pleasant* (40½ acres approx.).—Includes old M.L. 244 and Claim 652. Held by the Nickel Kramer Tin Mining Co., Ltd. The tin-bearing material consists of a wash and an ironstone conglomerate requiring crushing. It has been worked on a small scale for many years by opencuts, and by means of 40 or 50 shafts, which reached bottom at from 15ft. to 30ft. The recorded output from this ground is :—

To end of 1905, M.L. 244	36·45 tons	£2,995
1906, M.L. 244	7·85 „	801
1906, Cl. 652	1·55 „	155
Total	45·85 „	£3,951

Claims 608 (22 acres) *and* 700 (32½ acres).—These lie immediately below M.L. 471, occupying the head of the main channel of Spring Gully. Outputs :—

1906—Cl. 608	21·90 tons	£2,083
Cl. 700	58·85 „	5,928

Claim 318 (28 acres approx.), known as the Old Spring Gully, or Sinclair's Claim.—This is one of the oldest and most productive alluvial claims on the field. It occupies a narrow strip of the main gully for a length of ¾ mile. The deposit in this claim consists of two distinct portions, an upper or "free dirt," and a lower, or "stiff clayey dirt." The former was loose and gravelly, being composed of fine and coarse quartz [694, 695] of a somewhat violet tinge, and granular structure very typical of Greenbushes. It was from one to three feet thick, about 18 to 20 yards wide, and proved exceptionally rich in tin. The latter consisted largely of a stiff white clay [1633] containing irregular bands of fine cassiterite associated with garnet, zircon, tourmaline, and gahnite (zinc spinel) in irregular grains and well-formed crystals of all shades of green [697]. Occasional small pieces of metallic tin are found in the wash. These have probably been reduced from surface ore during bush fires. In 1890 Mr. H. P. Woodward reported of this claim:—

> "The wash....carries about 1lb. of tin in the dish. In some places in the head of the gully very rich pockets of wash are met with from 6ft. to 10ft. in depth.....Up to the present about 50 tons of tin have been sent away, and about as much more will be washed out this winter. It is a wonderfully rich claim, and about the easiest to work on the whole field."

Mr. A. Gibb Maitland considers that a large proportion of the stream tin in this claim was derived from the tin-bearing granite about the head of Mulligan's Gully.

Of the actual output of this claim no complete record has been kept ; the following figures appear to be the only ones available :—

Previous to 1899 ...	40 00 tons ...	£1,600
1899	21·75 „ ...	2,065
1900	No returns available.	
1901	7·85 tons ...	£386
1902	5·45 „ ...	368
1903	14·82 „ ...	1,041
1904	17·80 „ ...	1,277
1905	30 95 „ ...	2,736
1906	23·35 „ ...	2,518
Total ...	161·97 „ ...	£11,991

Claim 758 (6 acres approx.) is situated in Mulligan's Gully. Output—1906, 0.40 tons, £43.

M.L. 387, *Stanhope* (10 acres).—On lower end of south branch of Spring Gully, includes part of old M.L. 87, Sinclair's. Output—1906, 6.53 tons, £704.

Claim 684 (4 acres approx.) is on the north end of Paperbark Swamp.

In addition to the leases and claims mentioned above, the whole of the lower part of Spring Gully and the valley of Norilup Brook is held under lease or claim. No output from these having been recorded during 1906 no further reference to them here is deemed necessary.

Cowan Gully, south of Spring Gully, is drained by Cowan Brook and its tributary, Moulton Brook, both flowing west and ultimately entering Norilup Brook. The upper parts of these streams are occupied by broad swampy flats surrounded by laterite covered rises, but like the others in the district as they proceed farther west they run in comparatively narrow rocky channels. Tin mining appears to have been largely confined to the upper portions of the valley.

M.L. 416 (313), *Battlers Hope* (20 acres).—Situated at the head of Moulton Brook. This lease was reported on by Mr. A. Montgomery in 1903. He found that a shaft at a depth of 93ft. had cut a deep lead, the wash being 15in. thick and composed of clay and sand carrying a little tin and numerous large and well-rounded boulders of quartz, greisen, mica schist, etc. The bottom dips at a low angle to the north-west. The lead was driven on where struck but was too poor to pay working. The lease has never been on the list of ore producers.

Claim 759 (4 acres approx.) on Moulton Brook, a little west of M.L. 416. Output—1906, 0.30 tons, £26.

M.L. 357, *Aurora* (48 acres) is at the head of Cowan Brook, and is held by the Greenbushes Consolidated Tin Sluicing and Mining Company. Output (alluvial ore):—

To end of 1905	...	21·33 tons	...	£1,826
1906	...	40·40 „	...	£3,800
Total	...	61·73 „	...	£5,626

Claims 705 (3 acres) and 734 (8¼ acres approx.) lie immediately north of M.L. 357. Output:—

Cl. 705	...	1906	...	5·80 tons	...	£571
Cl. 734	...	1906	...	1·80 „	...	£167

Bunbury Gully.—This valley which rises a short distance to the south-east of the town falls to the south-south-east at the rate of about 250 feet in the mile, and with two branch gullies running from the west has been the scene of considerable activity ever since Stinton's first discovery of tin ore near the present Government Battery. Within this valley tin ore has been obtained from lodes, from deep leads, and from more or less shallow alluvium. The stream ore here is not so pure as in the valleys previously described, lodes and leads carrying tantalite and stibiotantalite having been located at the head of this valley, and these minerals contaminate all the dressed tin to a greater or less extent. Near the head of the valley a little water-worn gold has frequently been encountered in the tin concentrates.

M.L. 369, *Enterprise* (14¼ acres approx.) lies on the main road near the head of the gully. It includes a small portion of old M.L. 140, Acme. In December, 1905, Mr. W. D. Campbell reported on this lease which is chiefly interesting as being a producer of tantalite as well as tin ore. A more complete description will therefore be found on page 113. Output of tin ore—1906, 2.50 tons, £177.

Claim 781 adjoins Reserve 1381, Greenbushes Well.—Speaking of this ground in 1900, the Government Geologist says:—"A shaft has been put down to a depth of about 12ft. The sinking exposed 4ft. of modern alluvium, and the remainder a kaolinic rock with white mica and tourmaline; the rock is evidently a decomposing granite. A few yards to the west of the lower slopes of the valley a 9ft. shaft discloses an ironstone rubble of about 4ft. in thickness, resting upon decomposing granite."

Output during 1906, 0.35 tons, valued at £35.

Claims 712 *and* 762, worked in conjunction, lie just south of the Greenbushes Well. Speaking of this part of Bunbury Gully in 1900, the Government Geologist says*:—"Two vertical shafts of about 30ft. in depth are connected underground. In the workings a well-marked 'tin floor' underlies at a comparatively low angle to the west. The material forming the 'floor' locally spoken of as 'wash' is about 2ft. 6in. in thickness, and consists of mica, quartz, a little tourmaline, and tin. The deposit in all probability represents the decomposed portion of one of those tin-bearing veins by which the granite is reticulated. The most southerly shaft on the claim, at a slightly lower altitude, has a depth of about 20ft. and the 'wash' only about 1ft. in thickness." Output—1906, 9.55 tons, £905.

Claim 738 (5½ acres approx.) is immediately south of Claim 762. Output—1906, 4.87 tons, £471.

M.L. 410, *Tairua,* includes part of old M.L. 124, Killarney, and is situated on the laterite ridge east of the Greenbushes Well. A lode has been worked in this property yielding, during 1906, 1.49 tons of black tin, valued at £165.

M.L. 389, *Esperance Hill* (10 acres) includes part of old M.Ls. 124, Killarney, and 61, Yarana, and joins M.L. 410 on the south-west. During 1906 this lease produced a little lode tin, viz., 0.15 tons, of the value of £15.

M.L. 401, *Nil Desperandum,* during 1906 treated 137.2 tons of lode stuff for a yield of 0.98 tons of tinstone, valued at £104.

M.L. 382, *Dreamland* (10 acres), includes part of old M.L. 61, Yarana. A tin lode running in a north-west direction has been described as occurring under a cover of 3ft. of cement. This lease has yielded:—

To end of 1905	1·32 tons ...	£139
1906	·85 ...	91
Total	2·17 ...	£230

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* Ann. Prog. Report of the Geological Survey for 1899, p. 18. Perth: By Authority, 1900.

M.Ls. 73, *King Tin* (late Nelson); 271, *King Tin North* (late Pioneer); and 233, *King Tin South*. (Total area, 40 acres.)—These leases are now worked together, but in the past were once worked separately, and later M.Ls. 73 and 233 in conjunction as the Nelson leases. Describing this area in 1900, the Government Geologist says :—"On Kramer's Claim a vertical shaft 34ft. in depth intersected a decomposed tin floor of from three to four feet in thickness.The floor has a gradual dip to the south-west. The deposit is very rich in tin, the ore being often rounded or subangular [1283]. In that portion of the property which lies close to the bank of the gully, very sharp bright angular tin [1284] occurs at a very short distance below the surface. The ore must have been released from its parent source not far from where it is at present found."

Recorded output from these leases:—

To end of 1905,	M.L. 73	22·40 tons ...	£1,675
„	M.L. 271	1·84 „ ...	117
1906,	M.L's 73, 271, 233 ...	8·42 „ ...	789
	Total	32·66 tons ...	£2,581

M.L. 147, *Haphazard* (20 acres).—In 1900 the Government Geologist noted the occurrence of a lode on this property under three feet of cement. The strike was north-west. A small amount of lode tin (0.08 ton) was recorded as obtained during 1906. In other parts of the property the residuary sands and gravels have been worked with fair results. Some low-grade concentrates were found to be composed largely of quartz, garnet, limonite, magnetite, tantalite, zircon, and ilmenite, in addition to cassiterite. Output:—

To end of 1905 ...	7·78 ...	£468
1906 ...	·08* ...	8
Total ...	7·86 ...	£476

M.L. 393, *Lost and Found North* (includes part of old M.L. 146, Glencoe).—The Government Geologist's map of Greenbushes, issued in 1900, shows a lode in this lease parallel to that in M.L. 147. Lode tin was reported as being raised in 1906. Reported output:—To end of 1905 (?). 1906, 0.73 tons,** £85.

M.L. 374, *Lost and Found* (includes part of old M.L. 56, Amanda). Mr. W. D. Campbell visited this lease in December, 1906, and reported :—

"Here a shaft 54ft. deep in kaolinised granite has been sunk on a lode composed of four veins or bands of about five inches each, in a total width of four feet, having an underlay of about 25 degrees to the east, and a strike of 40 degrees. The formation is gneissic, and slightly ferruginous in places ; no lode mining has previously been done here. This formation carries crystals of tin [6516] and tourmaline, and resembles the lode in the Cornwall lease.** I was informed by Mr. Andrew that in the lead of tin-wash near here a solitary specimen of gold was found, weighing 1½grs., at 24ft. depth."

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* From 20 tons lode stuff.　** From 86 tons of lode stuff.

Output :—

To end of 1905	0·75 tons	£70
1906	5·65 „	632
Totals	**6·40 tons**	**£702**

Claims in Elliott's Gully.—This gully is a branch of Bunbury Gully, entering the latter near M.L. 374. A good deal of prospecting has been done along this valley, the walls of the watercourse being composed of the laterite which forms the bulk of the watershed. A true deep lead apparently exists in this valley, and has been exploited to a considerable extent.

Claim 219A. (8 acres).—This is Elliott's old claim described in 1900 by the Government Geologist in the following terms :— "A great deal of work has apparently been carried out upon the property at different times. The main working shaft is situated near the northern bank of the gully, and has been carried down to a vertical depth of slightly over 50ft. To the top of the wash is 50ft. The 'wash' is a very coarse conglomerate with a very large proportion of flat-sided boulders, cemented together in part with oxide of iron [1239, 1240]. Tin shows freely in the different portions of the conglomerate. The average thickness of the deposit is about two feet........the floor upon which the deposit rests dips at a low angle to the south-east. Directly overlying the conglomerate is in places a fairly extensive deposit of white gritty sand, which contains detrital tourmaline." Just to the south of Elliott's shaft an opencut showed 12in. to 18 in. of coarse wash at a depth of six feet under yellow surface sand and ferruginous conglomerate. The output of this claim during 1906 was :—16.60 tons, £1,639.

Claim 710 (8 acres approx.) is immediately west of Claim 219A. Output during 1906 :—2.10 tons, £199.

Claim 683 (6 acres approx.).—Includes old claims 662 and 682. Lies south of claim 219A., and east of Claim 710. Output during 1906 :—2.70 tons, £255.

Claim 748 (1 acre approx.).—On west side of M.L. 233. Output during 1906 :—1.44 tons, £136.

Claims 779, 775, 789, 752, 753, 776, and 774 are close to the Government Battery site at the junction of Elliott's and Bunbury Gullies. Tin was first found on the field hereabouts, and at the

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436 tons of lode stuff crushed during 1906 yielded 5·65 tons of tinstone, equal to 0·91 per cent. of metallic tin in the original ore.

present time very extensive alluvial deposits are being worked on several of these claims. Outputs during 1906 :—

Cl. 779	0·60 tons	£62
775	10·65 ,,	991
789	0·77 ,,	79
752	8·50 ,,	821
753	7·20 ,,	786
776	0·30 ,,	30
774	0·75 ,,	75

Claims 771, 695, 746, and 750 are in Westralia Gully, a second tributary of Bunbury Gully, entering from the west a little further south than Elliott's Gully. These claims lie to the east of Hester's Spring (Res. 1382). The Government Geologist, in describing this locality in 1899 says :—" The vicinity of Hester's Troughs has been the scene of vigorous prospecting. The higher ground to the south of the troughs is covered with the ferruginous conglomerate ....This deposit prevents an examination being made of the underlying rocks, a difficulty which, however, has been partially overcome by the prospecting operations. What is known as Wright's shaft.. ..on the rising ground to the south of the troughs had been carried down to a depth of 28ft. vertically below the surface. The sinking showed : detrital conglomerate, 5ft. ; sharp gritty sand, 9ft.; tin-bearing wash, 1ft. The bottom has a slight underlie to the north-east.......In the vicinity of the shaft several very large pieces of angular tin, one weighing about 3lbs., have been discovered ......the tin cannot have travelled far from its parent source. On the flat ground to the north several excavations have been made, and they all unite in giving what is practically a uniform section, which consists of from 2ft. to 3ft. of peaty soil, succeeded by a very variable thickness of white gritty sand, carrying various proportions of mica and tourmaline." In 1900 the Government Geologist described tin lodes as occurring to the south of Hester's Spring.

The output during 1906 of the four claims in this vicinity was:—

Cl. 771	0·35 tons	£37
695	0·60 ,,	60
746	11·85 ,,	1,175
750	13·70 ,,	1,397

The last-named claim is the southernmost producing property on the field.

Salt Water Gully and Main Ridge.—The leases along the main ridge forming the watershed between Norilup Brook and its tributaries and the upper portions of Hester's Brook are conveniently considered in conjunction with the deposits in the latter valley. The ridge, which reaches a height of 900ft. above sea level is covered with laterite beneath which in the granitic rocks, several important lodes have been worked.

Salt Water Gully, through which Hester's Brook flows, rises to the south-east of the railway station and falls to the south-s east. It receives three tributaries from the west. The first (Scandinavian Gully) begins a little north of M.L. 116 ; the second (Floyd's Gully) rises in M.L. 383 ; the third (Kelly's Gully) in M.L. 182. Tin ore has been obtained from the main gully and all three branches. Laterite covers the higher ground in this watershed, but granite and gneiss appear at the surface in the lower parts of the valleys.

Claim 792.—At the head of the main valley, between the racecourse and quarry reserve 6714. This isolated claim has yielded :—1906, 0.45 tons, £44.

Claims 744 and 782.—To the south of the racecourse, at the head of the first branch of Salt Water Gully. Output during 1906 :—

Cl. 744	1·47 tons	£144
782	0·17 „	17

M.L. 388, *Dixie* (24 acres).—On the laterite ridge immediately east of the town. It includes part of old M.Ls. 71, Jeffery, 156, New Zealand Syndicate, and 104, New Guinea. A lode is being worked in this property of which specimens from a depth of 120ft. are in the Departmental Museum [6998]. These show that the lode is a pegmatite vein, composed largely of albite, with lesser quantities of quartz, tourmaline, muscovite, garnet, and cassiterite. Its average grade can be gauged from the fact that 239 tons crushed during 1906 yielded 1.92 tons of tinstone. The output of this lease has been :—

To end of 1905	0·52 tons	£42
1906	2·12 „	247
Total	2·64 „	£289

M.L. 422, *Cornwall Extended.*—This lies between M.Ls. 388 and 356, and includes part of old M.L. 51. During 1906 it yielded 0.25 tons of lode tin, valued at £25.

M.L. 356 (40), *Cornwall* (20 acres).—This is one of the oldest leases on the field, and was the first upon which a distinct lode was opened up and worked. As far back as 1900 a shaft 120ft. deep had been sunk to cut the lode. Shafts and crosscuts have shown the country to be chiefly granite and hornblende-biotite schist (altered bronzite diabase ?) [6514], whilst the lodes are pegmatite veins of variable character. The constituents of these veins are quartz, albite, muscovite, tourmaline. At times they are strongly foliated [687]. Mr. W. D. Campbell writes of this property in December, 1905* :—

"The old workings comprised several shafts from 60ft. to 120ft. depth on the various lines of lode, of which there appear to be four in number, striking about 161 degrees, with a westerly underlay of 84 degrees. The two western lodes at least are in decomposed granite, and either one or two of the eastern lodes are probably in the dark mica schist [6514] showing in the dump of the 120ft. shaft. Very little stoping appears to have been done by the past owners.......The present owners have been stoping and driving from the old workings at 60ft. to the surface of the decomposed rock, which is overlaid by about 7ft. of tin wash and gravel. They state that they found rich patches of ore. They have also sunk several minor shafts with drives and stopings, and have been well satisfied with the mine......I inspected part of the workings down to 50ft. depth......the lodes are somewhat sinuous, and vary from 18in. to 5ft. in width, and are approximately parallel, though probably not all continuous through the lease."

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* Annual Report Geological Survey for 1905, p. 18.

A typical sample of slightly foliated ore [1945] composed of albite, tourmaline, mica, quartz, and tinstone, and collected from the dump of the 120ft. shaft, assayed 1.79 per cent. of metallic tin. Three bulk samples of similar ore raised in 1900 assayed respectively 0·55 per cent., 3·46 per cent. [1999], and 1·09 per cent. The 495 tons of lode stuff crushed during 1906 yielded 5.38 tons of tinstone, equal to 0.76 per cent. of metallic tin in the original ore.

The recorded output of this lease is :—

1902	4·14 tons ...	£250
1903	4·93 „ ...	349
1904	2·33 „ ...	163
1905	11·30 „ ...	874
1906	5·38 „ ...	566
Total ...	28·08 ...	£2,202

M.L. 300, *South Cornwall* (20 acres).—Lies to the west of M.L. 356, and includes old M.Ls. 101, 89, and part of 54. In this lease a lode parallel to those in the Cornwall has been worked, and near the surface yielded some of the richest lode stuff yet raised on the field; see specimen [4660] in the Geological Museum. Mr. W. D. Campbell writes in December, 1905 :—"The main shaft is 80ft. deep, and the lode adjacent is stoped from 63ft. to the surface for a width of 8ft. from the western side where the schist is more decomposed. There is a crosscut east for 78ft., which the owners state is tin-bearing all the way......the country rock is mica schist. About 100ft. farther north the lode has been opened up by a 50ft. shaft, and is stoped from 50ft. to surface for about 250ft. in length."

Some of the richest ore from this mine [4660] was very micaceous, being composed of pale-green muscovite, quartz, topaz, and very coarse tinstone. A large specimen [7198] from a depth of 130ft. recently received from this mine shows a compact somewhat banded lode composed mainly of albite, with quartz, tourmaline, topaz, and cassiterite; 540 tons of lode stuff from this mine were crushed during 1906 for a yield of 4.25 tons of tinstone.

The recorded output of this lease is :—

To end of 1905	...	14·84 tons	...	£1,071
1906	...	4·25 „	...	440
Total	...	19·09 „	...	£1,511

M.L. 383, *Great Wonder* (10 acres).—Covers part of old M.L. 46, Cosgrove Consolidated, and lies south of the Cornwall, M.L. 356, and at the head of Floyd's Gully. During 1906 this lease reported 0.15 tons of black tin, valued at £12.

Claim 770 (4 acres approx.).—On the north slope of Floyd's Gully yielded during 1906 a total of 0.80 tons of tinstone, valued at £80.

Claims 745, 801 (includes old claims 725, 733, 736, 742, 751, and 693), 741 and 670 are in the bed of Floyd's Gully. Their output during 1906 was as follows :—

Cl. 745	...	4·66 tons	...	£410
801	...	2·40 „	...	260
741	...	0·85 „	...	85
670	...	1·10 „	...	113

Claims 648 and 315 are in the bottom of the main Salt Water Gully, just below Floyd's Gully. Output during 1906 0.60 tons, valued at £57.

Several recently unproductive leases and claims are situated in Kelly's Gully and in Salt Water Gully below the junction of the two.

NANNUP (SMITHFIELD).

In his Annual General Report for 1890, Mr. H. P. Woodward, then Government Geologist, states that the Greenbushes "line of tin-bearing country extends in a north and south direction, and it has been found in places across the country as far north as the Preston River, and south beyond Bridgetown."* In spite of this there is no record of any tin mining having been done outside the limits of the Greenbushes Tinfield, as constituted in 1892, until early in 1907. On the 14th March in this year Messrs. G. Gough and W. O. Smith applied for a reward claim at Nannup, or Smithfield, eight miles south-west of Bridgetown, and about twelve miles south of Greenbushes.

Mr. H. W. B. Talbot, Geological Field Assistant, visited this find a few days later and reported:—

"The present workings are situated near the eastern edge of what is probably the same line of country as that which extends in a southerly direction from Greenbushes Tinfield. The geological features of the country surrounding the new find are very similar to those found at Greenbushes, and consist of crystalline rocks,** covering a very large area to the eastward, ferruginous conglomerate, ironstone gravel, and alluvial deposits. In several places there are outcrops of pegmatite dykes, which for the most part strike in a northerly and southerly direction. These dykes are composed principally of quartz and felspar '(mainly albite, E.S.S.)' with smaller quantities of mica and tourmaline. There can be but little doubt that it is from some of these pegmatite veins that the alluvial tin found in the prospector's claim has been derived. The wash raised from the shafts in the prospecting area consists of boulders of quartz of the same type as that seen in the pegmatite dykes, and small pieces of tourmaline, embedded in a stiff white clay; and occasional pieces of undecomposed felspar were also found among the wash stones. The wash in the shaft accessible is twelve inches in thickness, and has a slight dip to the south-west.

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* Annual General Report for the year 1890, by Harry Page Woodward, Government Geologist, p. 46. Perth: By Authority, 1891. ** Granite with dykes of diabase. E.S.S.

"Three-quarters of a dish of dirt washed in my presence yielded about half an ounce of tin oxide and seven or eight fine specks of gold. Underlying the tin-bearing wash there is a fine-grained compact sand, showing numerous particles of mica and tourmaline. There appears to be no reason why another layer of wash should not be found under this sand, but in all probability a large flow of water would be struck before the whole thickness of sand was penetrated.

"At Moriarty and Payne's Claim, about half a mile down the creek from the prospecting area, I washed a shovelful of dirt obtained from a thin layer of wash about two feet below the surface, which yielded a few grains of tin about the size of a pin's head.

"The only other claim on which tin had been found at the date of my visit was on Hearn and Party's claim, situated at the north-west corner of the prospecting area. On this claim a shaft is down 20ft., and at the bottom there is a layer of wash about a foot thick, a dish of which yielded a small quantity of tin and a few specks of gold. The wash is of the same type as that in the prospector's shafts."

A sample of the roughly concentrated tin ore from Gough and Smith's claim, brought to Perth by Mr. Talbot, had a total weight of 31.3 grammes, and was composed of quartz, 9.10 grammes; tourmaline, .35 grammes; minerals with specific gravity over 3.3, 21.85 grammes.

This last (heaviest) portion was made up of cassiterite (4),[*] zircon (3), ilmenite (2), green isotropic mineral, probably gahnite (1), magnetite (1), gold (1), and rutile (1). On making a sizing test the following results were obtained :—

A.	Diameter over 1·0 m.m.	... ...	31·6 °/o
B.	,, ,,	... ...	41·7
C.	,, ,,	... ...	17·1
D.	,, ,,	... ...	9·6
			100·0

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[*] The figures in brackets represent the relative quantities of each mineral present.

The greater part of the tinstone was in grades A and B. It formed altogether about 65 per cent. of the heaviest concentrates, equal to about two-thirds of an ounce to the dish.

Very little has been heard of this field since March.

WESTERN AUSTRALIA.

Production of Tin Concentrates.

Year.	Moolyella.		Cooglegong.		Eley's. (Old Shaw.)		Wodgina, Stannum, and Mills' Find.		Greenbushes.		Total.	
	tons.	£	tons.	£	tons.	£	tons.	£	tons.	£	tons.	£
1888 ...	...	...	...	...	?	...	...	...	...	...	.	...
1889 ...	...	...	...	...	?	...	...	...	5·00	300	5·00	300
1890 ...	...	...	...	...	Very small. No record of any exported.	...	...	...	67·50	5,400	67·50	5,400
1891 ...	...	...	...	...		...	...	...	204·00	10,300	204·00	10,300
1892 ...	...	...	...	...		...	...	...	265·49	13,843	265·49	13,843
1893 ..	...	...	...	...	56·45	3,470	...	...	171·50	7,664	227·95	11,134
1894 ..	...	...	...	...	19·00	949	...	...	371·25	14,325	390·25	15,274
1895 ...	...	...	...	...	Nil	...	...	...	277·15	9,703	277·15	9,703
1896 ...	...	...	...	...	Nil	...	...	...	137·25	4,838	137·25	4,838
1897 ...	...	...	...	...	Nil	...	...	...	95·55	3,275	95·55	3,275
1898 ...	...	...	...	...	Nil	...	...	...	68·14	2,760	68·14	2,760
1899 ...	54·75	3,288	...	...	2·75	124	...	...	277·32	21,658	334·82	25,070
1900 ...	318·81	28,187	65·06	3,687	4·00	300	...	...	435·62	29,528	823·49	56,702
1901 ...	231·20	11,911	174·43	8,880	7·35	357	...	...	321·34	18,852	734·32	40,000
1902 ...	104·55	7,407	91·80	6,373	19·00	1,267	1·00	56	403·21	24·680	619·56	39·783
1903 ...	103·75	7,961	173·59	12,541	14·02	981	0·75	45	524·94	34·362	817·05	65·890
1904 ...	117·00	8,948	114·34	8,664	80·57	6,107	8·95	636	533·64	34·462	854·50	58·817
1905 ...	256·21	18,727	141·13	12,034	17·65	1,394	20·75	1,725	648·52	52·960	1,079·26	86,840
1906 ...	518·92	57,133	147·09	16,284	Nil	...	45·64	5,032	783·28	79,195	1,494·98	157,644
Totals ...	1,705·19	138,562	907·44	68,463	220·79	10,530	77·09	7,494	5,585·70	367,605	8,496·21	592,654

LEAD.

The principal commercial ores of lead and their physical properties are as follow :—

Galena.—Sulphide of lead, PbS. The commonest ore of lead : contains 86 per cent. of lead, and generally contains more or less silver. Lead grey, metallic, opaque, crystallised with cubic cleavage, or granular and massive. Soft brittle. Sp. Gr. 7.5

Cerussite.—Carbonate of lead, $PbCO_3$. The second most important ore of lead : usually found in the upper or oxidised portions of the lodes. Contains 77.5 per cent. of lead. White, grey or greyish black, transparent to opaque, crystallised, granular, or massive, soft, very brittle. Sp. Gr. 6.5.

Anglesite.—Sulphate of lead, $PbSO_4$. Found in the oxidised portions of lodes. Contains 68 per cent. of lead. White, tinged with yellow, grey, or green ; transparent to opaque: Soft and very brittle. Sp. Gr. 6.2.

Pyromorphite.—Chlorophosphate of lead, $Pb\ Cl_2\ 3Pb_3\ P_2O_8$, not a very common ore, contains 62 to 75 per cent. of lead. Green, yellow, or brown. Translucent to opaque, resinous ; crystallised or massive. Soft, brittle. Sp. Gr. 6 to 7.

Early History of Lead Mining in West Australia.

The first discovery of lead in this State dates back to 1848, in which year lead-bearing reefs were discovered on the Murchison River ; specimens from here were received in Perth in August, 1848, and on being sent to Adelaide for assay, were found to contain not only lead and copper, but also traces of gold, and one specimen the assayer certified as being extremely rich in silver.

The Government immediately despatched a party to the locality, under the leadership of Mr. A. Gregory, who reported : "Mr. Walcott brought in some specimens of galena, which proved to be abundant in the bed of the river."

On the 20th March, 1849, the property was offered for public sale, and was bought by a Perth Company. The mine was named the "Geraldine." Messrs A. O'G. Lefroy, G. Shenton, and R. M. Habgood were elected trustees of the Company, and Mr. W. Burges, superintendent. The property again changed hands in 1850, and the new company started to erect furnaces, and this year ore to the value of £55 was exported to England, and during the next few years many thousands of pounds' worth of pig lead was shipped.

Several other mines were opened up in the Northampton district about this time, and some good ore was taken out. Practically all of these properties have now been abandoned for a number of years.

In 1872 rich lead and copper deposits are reported to have been discovered near Roebourne.

About 1871 lead ore was discovered at two places near Cardup, and from one of them, known as Herbert's Mine, a few tons of ore were raised. It would appear that this mine is the one at present being prospected under the name of the Mundijong Silver and Lead Mine.

Some years after this lead ore was discovered at Uaroo and other places on the Ashburton Goldfields, and still later, near Derby, in the Kimberley District. Ore is at present being obtained in both these districts, but so far only in a small way.

The following is a list of localities from which lead ore is reported to have been raised :—

Kimberley.—Narlarla Hills.
North-West.—Roebourne, Uaroo, Westons.
South-West.—Geraldine, Narra Tarra, Northampton, Oakagee, Mundijong.

The following is a list of localities from which the occurrence of lead has been reported :—

Division.	Centre.	Nature of occurrence.
Kimberley	Panton River	Galena in quartz.
Do.	Ivanhoe Station	Massive carbonate ore.
Do.	Hall's Creek	Galena in quartz.
Do.	Brockman's	do.
Do.	Ruby Creek	do.
Do.	Ord River	Galena in limestone.
Do.	Mt. Dockrell	
North-West	Andover	Galena in quartz.
Do.	Gorge Creek	Cerussite and galena in quartz gangue.
Do.	Hardy River	
Do.	Mt. De Courcey	Massive galena.
Do.	Mt. Edith	do.
Do.	Tambourah	do.
Do.	Warrawoona	
Do.	Whim Creek	Cerussite in quartzose lode matter.
Do.	Yannarie River	Massive galena.
Do.	Horseshoe	Small pockets of galena in quartz reef.
Do.	Nannine	
Central	Coolgardie	Small pockets of galena in auriferous lodes.
Do.	Comet Vale	Crocoisite (chromate of lead) in quartz reef.
Do.	Erlistoun	Galena in auriferous quartz reef.
Do.	Menzies	Small patches of galena in auriferous lodes.
Do.	Mulline	Small quantities of vanadinite in auriferous quartz reef.
Do.	Mulwarrie	Galena in auriferous quartz reef.
Do.	Pinyalling	Small quantities of vanadinite in quartz reefs.
Do.	Southern Cross	Small quantities of galena in auriferous quartz reefs.
Do.	Wilson's Patch	Small bunches of galena in quartz reefs.
South-West	Cardup	Massive galena.
Eucla	Norseman	Small quantities of galena in auriferous quartz reefs.

General Description of the various centres (as far as known) in which lead ore has been worked, with such particulars of the various mines as are available.

KIMBERLEY DIVISION.

NAPIER RANGE (NARLARLA HILLS).

The rocks of the Napier Range consist of crystalline limestones, and have been classed by the late Mr. E. T. Hardman as Lower Carboniferous. The rocks strike in a north-west and south-east direction, whilst the individual beds dip at an angle of about 20 degrees to the south-west; the lower or basal beds consist of limestone conglomerates containing fragments and boulders of the schistose and granitic rocks, which underlie them uncomformably.

The Narlarla lead leases are situated at the top of the range upon the south side of the Barker gorge.

The ore deposits consist of two small parallel iron-stained blows of carbonate of lead about 20 chains apart, whilst the limestone country between is found to contain small stains of carbonate of copper, which apparently give rise to the belief that the lodes ran in a north and south direction.

These blows, upon development, proved to be small veins of lead ore, following the bed of the rocks, the caps of which have fallen over, thus making a considerable surface show.

The south blow, from which some high-grade ore was obtained at the surface, was found upon sinking to pass into iron pyrites with little or no lead at a depth of 8ft. or 9ft.

The north blow is better defined, and of slightly greater length. The ore at the surface is iron and copper-stained carbonate of lead, but this passes rapidly into sulphides at water level (20ft.) : at this depth there is a well-defined vein of galena, about two feet in thickness, the rest of the lode carrying a considerable quantity of zinc and iron pyrites.

There are a good number of tons of fair ore in sight here, but the cost of mining, transport, and treatment is too great to allow the deposits to be payable, more especially as the lodes give no indication of continuity, either horizontally or vertically.

The following are the results of assays of samples of ore from the Napier Range (Narlarla Hills) recently made in the Geological Survey Laboratory.

No.	Locality.	Nature of Ore.	Lead.	Copper.	Zinc.	Gold.	Silver.
						per ton.	per ton.
2352	Narlarla	Oxide ...	48·39%	4·43%	4·47%	3 grains ...	4·4 ozs.
2353	Do.	Sulphide ...	13·94%	0·42%	40·83%	Nil	3·3 ozs.
2354	Do.	Transition	39·66%	0·52%	1·34%	Trace ...	5·0 ozs.

NORTH-WEST DIVISION.

ROEBOURNE.

Lead ore is said to have been raised from this district, but no particulars about it are available.

ASHBURTON DISTRICT.

UAROO.

The rocks of this district consist of crystalline schists associated with granitic gneiss ; they form a belt of about 50 miles in width, which has been traced in a north and south direction for some 150 miles. The granite gneiss apparently rises to the surface along the crests of anticlinal folds, along the flanks of which lie very much contorted crystalline schists. These schists often occupy basin-like depressions in the gneiss, and are apparently uncomformable to the latter.

The ore deposits of Uaroo occur in the crystalline schists, which have a north-westerly strike, and a steep dip to the eastward. The ores consist of carbonates and red oxide of copper associated with argentiferous lead ores.

Rainbow Reward Lease, M.L. 3.—The deposit, according to report, consists of a copper-bearing quartzite (?) which has been faulted, and along the line of which argentiferous lead ores have been introduced. Some very nice bunches of ore have been taken out from near the surface, and, according to the official returns, the property has produced 56.90 tons of ore, of a total value of £429 (up to the end of 1906).

This property has recently been taken up again, and is now being prospected by a small company.

A sample of carbonate of lead ore from near the Rainbow Reward was recently assayed, with the following results :—Lead, 61.86 per cent. ; copper, 0.18 per cent. ; zinc, 0.77 per cent. ; silver, 5.4oz. per ton ; gold, 17grs. per ton.

Weston's.—Silver-lead ore occurs here in association with the copper deposits.

Table of assays made in the Geological Survey Laboratory of samples of lead-copper ore from the Mt. Stuart District, Ashburton Goldfield :—

No.	Copper Per cent.	Lead. Per cent.	Silver. Ozs. per ton.	Gold. Ozs. per ton.
1483 ...	4·10	16·72	1·77	0·02
1484 ...	8·44	4·07	0.63	0·10
1485 ...	7·63	17·40	1·69	0·08
1486 ...	1·16	3·67	0·08	0·08
1487 ...	16·88	8·92	0·73	0·12

For results of more assays see page 86.

SOUTH-WEST DIVISION.

NORTHAMPTON DISTRICT.

The mining centres of Geraldine, Northampton, Narra Tarra, Oakagee are all situated within the Northampton Mineral District. The general description of the country and of the lodes is the same in each case, whilst these latter are identical in mode of occurrence with those in which the copper deposits occur, and in many cases both lead and copper are found to occur in the same lode, for a general description of which, etc., see page 31, under "Copper."

The following are such particulars as are available concerning the various lead mines in the Northampton Mining district. Most of them have been abandoned for many years, and the particulars are necessarily very meagre.

Geraldine Lead Mine, Block No. 1, 40 miles north of Northampton. It was worked from 1857 to 1878, during which period a considerable quantity of lead ore was raised and dressed. In the very early days smelting was attempted, but this proved a failure, so the ore was shipped from Port Gregory. Owing to incomplete records having been kept in the past, the exact quantity of ore raised from the property cannot be estimated.

Some extremely rich ore was raised in the early days of the mine from a lode said to consist of nearly three feet of almost solid galena ; the owners had many difficulties to contend with, however, principally the fact that the main shaft was sunk right in the bed of the river, and the mine was continually being flooded.

The general strike of the lode is about north-north-east, with a steep underlie to the west; the country being a garnetiferous gneiss.

The lode has been opened up to a depth of 320ft. on the underlay—about 260ft. vertical—and a good deal of work has been done on it. From reports it would appear that the lode, though larger, has decreased considerably in value at a depth.

North Geraldine Lead Mine, Location 4.—Situated about one and a half miles east of the Geraldine. The property was never worked to any great extent, and was abandoned about the same time as the Geraldine. The workings are only down about 50ft., and the lode is said to have been about 20ft. in width, and to have carried on the average about 10 per cent. of galena.

South Geraldine Lead Mine, Location 9 (about two miles south of the Geraldine).—This property was abandoned about 20 years ago, when the fall in price of lead took place. It has only been opened up to a depth of about 60ft., but about 500 tons of very rich ore are said to have been taken out, and the lode is reported to have been very high grade. This property was worked again in 1886, when it is reported to have produced 6.4 tons of ore, of a total value of £44.86.

Lady Florence Lead Mine, Location 2.—About a mile lower down the river than the Geraldine ; was originally the property of the Geraldine Co. There was apparently a large well-defined lode in the lease, which was worked from a number of shafts to a depth of 60ft. to 80ft.

Lady Maude Lead Mine.—This property has been worked to a depth of about 50ft., and some 60 tons of galena are said to have been raised.

Location No. 7 Lead Mine.—Owned by the Wanerenooka Company. It was worked from 1888 to 1890, and is said to have yielded about 700 tons of ore. The deepest workings are only down 40ft. to 50ft., but the lode is said to have been very rich.

Two Sisters Lead Mine.—These two leases were originally held and worked by the Geraldine Co., who opened up the lode at various points for a distance of about half a mile. The deepest workings were from 60ft. to 70ft., and the lode appears to have been from 10ft. to 15ft. in width, carrying small bunches of rich lead ore.

Four Mile Pool Lead Mine.—This property was on what was probably the continuation of the Two Sisters lode ; only a little work of a prospecting nature has been done on it.

Mary Spring Lead Mine.—Originally worked by the Geraldine Company. Two parallel lodes have been worked on this block to a depth of about 75ft., and apparently a large quantity of ore was raised and dressed at the Geraldine plant.

Lady Tilly Lead Mine.—Very little work has been done on this block, but about 120 tons of ore are said to have been shipped from it.

Wheal Lily Lead Mine.—Situated about three miles east of the Geraldine. There are a number of old shafts on the lease, and all the ore has been worked out to the surface, and the shafts have fallen in. The lode appears to have been of good size, and some nice ore was shipped.

NORTHAMPTON (including Oakagee and Narra Tarra).

Gray's Lead Mine.—Situated upon Freehold Block 29, about a mile to the north-east of White Peak Railway Station. The lode, which is traceable on the surface for a considerable distance north and south, has been opened up to a depth of about 40ft., and a considerable quantity of ore is said to have been raised about 40 years ago.

Gelirah Lead and Copper Mine.—Situated on Block 328, about 12 miles north of Geraldton. There are two parallel lodes on the property, the eastern one carrying copper ore, and the western one galena associated with zinc blende and iron pyrites. This lode strikes north-east and south-west, and dips to the east ; it has been traced on the surface for a distance of about 600ft., and has been opened up to a shallow depth by a number of shafts. A considerable quantity of lead ore is said to have been raised prior to 1860, when the mine was shut down ; it was reopened again for a short period in 1872.

Oakagee Lead Mine, Freehold Block 311 (16 miles from Geraldton).—The lode, which carries a considerable quantity of pyrites mixed with galena, strikes about north-north-east, and underlies steeply to the west. It has been opened up by means of two shafts 40ft. deep, and though it has only been worked on a small scale, is said to have produced several hundred tons of ore prior to 1870, when it was closed down. The lode is large, but not well defined, consisting of hard quartzite and granitic schist throughout which were found bunches and veins of galena and iron pyrites.

McGuire's Lead Mine.—On Block 832, 25 miles from Geraldton. It was originally opened by the Melbourne and Champion Bay Smelting Co., who had works on the lease, but these have long since been demolished.

One shaft has been sunk to a depth of 60ft. and one 30ft., and there are also several small pits and trenches, all being on a lode which evidently carried a considerable quantity of copper mixed with the lead.

Kobijawanna Lead Mine, about half a mile to the north of McGuire's. The lode has been opened up by a series of small shafts and pits, and in places show a nice body of carbonate ore. The property was abandoned in 1872.

Narra Tarra Lead Mine, Freehold Blocks 42, 336, etc.—The property formerly belonged to the Melbourne and Champion Bay Mining and Smelting Co., but is now in the hands of the Fremantle Smelting Co., who are at present doing some development work on it. There are said to be several lines of lode on the property, but most of the work is on the western one. A good vertical shaft was sunk to a depth of 180ft., and levels put in at 60ft., 120ft., and 180ft.; owing to the fact that this shaft was on the wrong side of the lode it was proposed to sink another to cut it (the lode) at about 300ft., after this was sunk about 150ft. the mine was abandoned and remained so until the present owners started work on it. A lot of work was done in the old days, and an extensive plant and smelting furnaces were erected. The main lode is said to have been large, with bunches and veins of galena in it. During the period the mine was worked—1870 to 1884—it is said to have produced £30,000 worth of ore.

Norman's Well Lead Mine.—About seven miles from Northampton, on the Narra Tarra road. The lode is said to have been well defined and of fair size, and runs north-east and south-west, with an underlie of about 60 degrees to the north-west. Several shafts were put down to depths up to 80ft., and, judging from appearances, a good deal of work seems to have been done.

Rhys Lead Mine, Freehold Block 436.—A small lead-bearing lode has been opened up here, and a little work done on it down to about 50ft.

Woomboaro Lead Mine, Blocks 325, 9. A lead lode runs through these blocks on the western side of a greenstone dyke. A series of shallow pits and trenches have been sunk on it, but not much beyond this, and the mine was abandoned years ago.

Baddera Lead Mine, Block 1472.—Two parallel lodes exist on this property, running in a north-west and south-east direction, and dipping steeply to the north-west. These vary in thickness from six inches to eight feet, and contain veins and bunches of lead ore so pure that the 677 tons of which a record has been kept averaged 72 per cent. Most of the work has been done at the south end of the lease, where the lode has been worked to a depth of about 100ft. ; at the north end it has been opened up to a depth of 72ft.

The property was discovered in 1873, and worked for about 10 years, since when little has been done on it. It now belongs to the Fremantle Smelting Co., who are at present opening up the mine again.

Wheal May Lead Mine, M.L. 20.—Situated about a mile and a quarter south of the Baddera. The lode runs about north-east and south-west, and averages about 18 inches in thickness. It has been opened up to a depth of 90ft. and a good deal of work has been done. The property has been abandoned for many years, but during the early years of its existence 2,200 tons of ore are said to have been raised, and to have realised £14 per ton.

Wheal Ellen Lead Mine, Block 1164.—The property of the Fremantle Smelting Co. The lode has the usual north-easterly and south-westerly strike, with a dip to the north-west. It has been opened up to a depth of 160ft., and for a length of 1,200ft., and there is said to have been one shoot of ore over 300ft. in length. The mine was first opened in 1872, and was vigorously worked for about 10 years, during which period it is estimated that £16,000 worth of ore was raised.

Uga Lead Mine, M.L. 6.—This lease has been worked to a depth of 75ft., and a good deal of ore has apparently been raised from it. It was worked first in 1873, and abandoned after a few years. The lode is said to have been of large size.

Strickland's Mine, Block 326.—This block adjoins the Uga on the south, and the workings are on the same line of lode. It has been worked to a depth of 75ft., and is said to have yielded a fair amount of ore. The lode in the bottom workings is said to have consisted of about two feet of almost solid galena.

Nooka Lead Mine, M.L. 7.—The lode here has been opened up to a depth of 90ft., but most of the work consists of opencuts and underlay shafts. The mine was worked in the later seventies, and is said to have produced about 1,000 tons of ore. A large percentage of zinc blende is found with the lead ore, some good bodies of which are said to still exist below water.

Chiverton, M.L. 8.—This block is on the south end of the Nooka Lease, and the same lode has been worked, as well as a second one a little to the west. The workings only extend to about 40ft. or 50ft. in depth, and not much appears to have been done. There is a good deal of zinc blende on the dumps, but apparently it is not in sufficient quantity to pay.

Kirton's Lead Mine, M.Ls. 1, 2, 3.—These leases were originally known as Kirton's and West Wheal Virgin, and upon them a line of lode was opened up for a distance of half a mile, there being three main shoots in this length ; these have been worked to depths of from 100ft. to 160ft. In the central lease the lode is said to have been crosscut for a distance of 30ft. without any walls being encountered; it was, however, very low grade. The mine was worked from 1873 to 1884, and was very rich in places. The lode material is highly siliceous, and carries galena in veins and bunches.

Yiapa Lead Mine, M.L. 5.—About 6 miles north of Northampton. The lode, which runs along the eastern side of a greenstone dyke, is said to have been about three feet in width, and very rich in places. It has been opened up to a depth of about 90ft., and is said to have produced some 500 to 600 tons of galena.

Iga Lead Mine, M.L. 4.—Very little work appears to have been done on this lease, but it is reported that some 400 tons of ore were shipped from it.

Ukkerheri Lead Mine.—This property was worked in the early days, and the lode was opened up to a depth of only about 30ft. Very little ore is said to have been raised.

Alma Lead Mine, M.L. 51.—The lode on this block is said to have been about three feet in thickness, and to have been proved on the surface by means of pits and trenches for a distance of 1,300ft. It was worked to a depth of 42ft., and is said to have yielded 28 tons of ore.

There are, in addition to the above, one or two other mines in which lead ore has been found—principally associated with copper ore—but which have not been worked for lead.

Table of Assays made in the Government Survey Laboratory of Samples of Northampton Lead Ores.

No.	Mine.	Locality.	Nature of Ore.	Parts per 100.		Ozs. per ton.	
				Copper.	Lead.	Silver.	Gold.
672	?	Northampton	Galena and quartz	..	70·3	0·26	Nil
1559	Geraldine...	Geraldine ...	Pyromorphite	*Nil*	62·5	*Nil*	*Nil*
3261	Landers ...	Narra Tarra...	Cerussite	*Nil*	66·9	0·25	Trace
3943	Mendip ...	do. ...	Cerussite and quartz ...	..	50·7	0·45	Trace
3944	do. ...	do. ...	do. do. ...	...	54·0	0·72	Trace
3945	do. ...	do. ...	Galena, cerussite and quartz	...	64·1	2·41	Trace
3930	Narra Tarra	do. ...	Galena, blende, quartz and granite	...	59·30	0·16	*Nil*
3931	do. ...	do. ...	Cerussite, galena and quartz	...	39·60	1·38	*Nil*
3941	do. ...	do. ...	do. do.	...	52·40	3·76	Trace
3942	do. ...	do. ...	Cerussite and quartz ...	...	44·30	0·98	Trace
4135	do. ...	do. ...	Galena and quartz	...	59·50	*Nil*	*Nil*
3927	do. ...	do. ...	Galena, cerussite and quartz	...	46·7	0·57	*Nil*
3928	do. ...	do. ...	do. do. ...	...	51·0	0·73	*Nil*
3929	do. ...	do. ...	do. do. ...	...	63·2	2·94	*Nil*
M. 183	Nooka ...	Northampton	Chalcopyrite, galena and quartz	5·34	8·60	*Nil*	*Nil*
4134	McGuires...	Oakabella ...	Galena, chalcopyrite and quartz	1·75	39·5	*Nil*	*Nil*
3214	(Commonage)	Northampton	Pyrites, pyromorphite, galena, quartz	...	12·27	0·54	Trace
3215	do. ...	do. ...	Cerussite, quartz	...	43·84	0·55	Trace

Nooka Mine.—Average sample of ore from dump:—Lead, 12.13 per cent.; zinc, 18.19 per cent.; copper, 1.04 per cent.; silver, nil. Ore consisted of quartz with blende, galena, etc.

Statement of Lead Ore raised from some of the Northampton Mines.

Name of Lease.	Date.	Tons of Ore.	Total Value.
			£
Baddera No. 1	1883	40·00	299·3
Do.	1884	29·70	172·6
Baddera No. 2	1884	14·45	67·2
Do.	1885	26·50	103·7
Do.	1886	0·40	2·5
Do.	1891	118·00	766·4
Uga No. 1 South	1883	163·25	1,218·7
Do.	1884	51·95	277·8
Do.	1885	174·00	965·5
Uga No. 2 South	1883	13·30	80·8
Do.	1884	2·20	10·70
Wheal Ellen	1883	0·20	1·80
Yiapa	1885	88·60	444·5
Baddera and South Uga	1884	143·70	789·0
Different Mines	1890	74·45	483·4

MUNDIJONG.

Mundijong Silver and Lead Mine.—The deposit which is at present being worked here occurs in a belt of highly inclined weathered schists near the foot of some granite ridges forming part of the Darling Range.

The lode is a strong body of quartz trending a little north of north-west, and can be traced on the surface for a considerable distance. Scattered through the quartz are dabs and bunches of galena and zinc blende.

A shaft has been sunk on this to a depth of 80ft. to 90ft., and a little work has been done at the 30ft. and 70ft. levels ; a winze has also been sunk a further distance of about 30ft. At the 70ft. level a crosscut has been put through the lode, which here consists of sixteen feet of almost solid quartz, with strings and dabs of galena and blende. In the winze there is some pretty dense blende, and a little galena.

As far as at present opened up the lode contains very little pure galena or blende that could be hand-picked for sale, but would require dressing and concentrating to obtain a marketable product.

There is very little silver associated with the galena, and less gold.

Analysis of Mundijong Ore made in Geological Survey Laboratory.

No.	Description of Ore.	Lead, per cent.	Zinc, per cent.	Copper, per cent.	Silver, ozs. per ton.	Gold, ozs. per ton.
2974	Gossan, quartz with cerussite, galena, blende, etc.	1·80	3·55	0·29	0·75	Trace
2975	Quartz with blende, galena and pyrites	7·54	15·46	0·15	0·45	Trace
2976	Blende, quartz and galena ..	4·63	43·75	Nil	0·75	Trace
2977	Quartz, blende and galena ...	9·53	23·40	Nil	1·95	Trace
2978	Quartz, galena and blende ...	12·64	7·63	0·40	3·30	Trace
2979	Quartz, blende and galena ...	4·94	19·28	Trace	0·95	Trace

The following table shows the results of some assays (other than those already referred to) made in the Departmental Laboratory of samples of lead ore received from time to time from various localities within the State :—

Locality.	Description of Ore.	Lead, per cent.	Copper, per cent.	Gold, ozs. per ton.	Silver, ozs. per ton.
Panton River, Kimberley...	Galena	70·0	*Nil*	*Nil*	26·60
Hall's Creek do. ...	Galena and quartz	52·2	...	*Nil*	11·80
Tambourah, Pilbara ...	Cerussite, etc.	43·3	*Nil*	·736	22·69
Do. do. ...	do.	60·1	*Nil*	*Nil*	88·31
Do. do. ...	Galena	64·5	*Nil*	Trace	68·75
Do. do. ...	do.	68·8	*Nil*	Trace	75·07
Andover, West Pilbara ...	Galena and quartz	52·5	*Nil*	·040	2·10
Balla Balla, Pilbara ..	?	63·5	·10	Trace	19·40
Do. do. ...	?	23 8	1·47	Trace	13·80
Mallina, West Pilbara ..	Galeua	58·4	...	Trace	24·40
Mt. De Courcy, Ashburton	do.	75·0	*Nil*	*Nil*	9·95
Do. do. ...	do.	74·2	*Nil*	*Nil*	2·45
Mt. Edith, Ashburton ...	?	63·9	*Nil*	Trace	2·70
Do. do. ...	?	30·8	Trace	*Nil*	16·95
Mt. Stuart, Ashburton ...	?	40·6	3·80	·040	1·05
Uaroo, Ashburton	Cerussite, etc.	25·7	*Nil*	Trace	1·55
Do. do.	do.	69·2	·86	·040	17·60
Do. do.	do.	23·5	*Nil*	Trace	·80
Yannarie River, North-West	Galena	73·0	Trace	·040	5·80
Do. do. ...	do.	69·6	1·30	·014	6·80
Gorge Creek, Ashburton	Cerussite, etc.	52·8	·65	·162	8·62
Do. do. ...	do.	55·3	·83	·064	4·37
Geraldine, North-West ...	Pyromorphite	62·5	*Nil*	*Nil*	*Nil*
Yalgoo, Yalgoo	Galena and ferruginous quartz	14·9	*Nil*	1·850	20·65
Coolgardie, Coolgardie ...	Galena	78·6	*Nil*	*Nil*	143·10
Horseshoe, Peak Hill ...	Galena and quartz	4·3	...	...	20·15

Two further samples from Uaroo, assayed at the Fremantle Smelting Works, yielded:—Lead, 67.8 per cent.; silver, 16.1ozs. per ton ; and lead, 67.3 per cent.; silver, 18.3ozs. per ton.

The following table shows the amount of lead ore reported to the Mines Department since 1899 :—

Centre.	Name and No. of Lease.	Tons of Ore.	Value.
			£
Ashburton	Rainbow Mine M.L. 3	56·90	429
Victoria	Alma 51	19·00	212
Northampton ...	Yiapa 62	30·00	195
Do. ...	Lady Maude 54, etc.	76·75	853
Narra Tarra	Locality generally	225·00	185

The following table shows the total amount of lead ore entered for export up to the end of 1899 :—

Lead Ore (Northampton Mineral Field).

Year.	Quantity.	Value.
	tons.	£
1850	5·00	55·00
1851	...	...
1852	...	...
1853	...	4·00
1854	...	...
1855	25·00	250·00
1856	...	...
1857	...	...
1858	...	...
1859	13·50	135·00
1860	98·50	985·00
1861	79·00	790·00
1862	9·00	90·00
1863	230·00	2,300·00
1864	80·00	800·00
1865	703·00	8,436·00
1866	273·50	3,282·00
1867	902·00	10,824·00
1868	1,100·50	13,206·00
1869	699·50	8,394·00
1870	1,209·50	14,514·00
1871	420·00	5,040·00
1872	364·00	4,368·00
1873	965·50	11,586·00
1874	2,143·75	25,725·00
1875	2,289·00	27,468·00
1876	2,191·50	26,298·00
1877	3,955·50	47,466·00
1878	3,617·50	43,410·00
1879	2,775·00	33,300·00
1880	1,921·00	15,368·00
1881	1,400·50	11,204·00
1882	1,793·50	14,348·00
1883	1,038·00	7,266·00
1884	696·00	4,872·00
1885	465·00	3,255·00
1886	611·00	4,277·00
1887	471·00	4,710·00
1888	532·00	5,320·00
1889	250·00	2,500·00
1890	213·50	2,135·00
1891	25·00	250·00
1892	29·75	150·00
1893	...	...
1894	...	...
1895	...	...
1896	...	...
1897	...	4·00
1898	5·00	33·00
1899	16·00	96·00
Total ...	33,617·00	364,514·00

ZINC.

The following are the principal commercial ores of zinc and their chief physical properties :—

Blende (*Sphalerite*).—Sulphide of zinc, ZnS. Zinc—57 to 67 per cent. Crystallised or massive, cleavable, granular to compact. Yellow, brown, or black, transparent to opaque. Soft and brittle. Sp. Gr. 4.0. Is the commonest ore of zinc.

Zinkite.—Oxide of zinc. ZnO. Zinc 74 to 80 per cent. Rarely crystallised, usually massive, granular, or foliated. Deep red to orange, translucent. Soft and brittle. Sp. Gr. 5.6.

Smithsonite.—Carbonate of zinc. $ZnCO_3$. Zinc—42 to 52 per cent. Crystallised or massive, granular, or earthy, also stalactitic. White or tinted, translucent. Hard and brittle. Sp. Gr. 4.4.

Willemite.—Silicate of zinc. Zn_2SiO_4. Zinc 48 to 58 per cent. Crystallised, massive, compact, or fibrous. White or tinted, transparent to opaque. Hard and brittle. Sp. Gr. 4.0

As far as official records show, zinc has never been worked in any part of Western Australia. It has, however, been known for many years to occur associated with certain lead ores, especially those of Northampton and Mundijong.

At Northampton, zinc blende has been found in fair quantity associated with the lead ore in the following mines :—(1), Wheal Ellen ; (2), Nooka ; (3), Uga ; and in the case of the Nooka and Uga mines is stated to be present in such quantity that under favourable circumstances it would probably pay to work in conjunction with the lead ores.

An average sample of the ore from the dump on the Nooka mine gave, on analysis in the Geological Survey Laboratory, the following results :—Lead, 12.13 per cent. ; zinc, 18.19 per cent.; copper, 1.04 per cent.; silver, nil. Ore consists of quartz with blende, galena, etc. The zinc blende in this ore is strongly cadmium bearing.

A description of the lead zinc deposit at Mundijong will be found under "Lead," on page 87, where a list of assays of several samples of the ore will also be found. No ore has been treated so far from this property, and it is still in the prospecting stage.

Zinc blende is frequently found in small quantities in the auriferous lodes and quartz reefs throughout almost the whole State. In the Lady Gladys Mine at Mulline it occurs in fair-sized pockets associated with iron pyrites. At Murrin Murrin it is found associated in considerable quantity with the copper ore in the Rio

Tinto Mine, and at Croydon (N.W.) it also occurs associated with copper ores, e.g., in the Evelyn Copper Mines.

Zinc has also been reported as occurring in small quantity at the following places :—

Division.	Centre.	Nature of occurrence.
North-West ...	Yandicoogina ...	Smithsonite with copper ore
Central ...	Kalgoorlie	In small quantities in auriferous quartz reefs
	Coolgardie	do. do. do.
	Laverton	do. do. do.
	Lawlers	do. do. do.
Eucla ...	Norseman	do. do. do.
	Wilson's Patch ...	Small pockets in quartz reef

ANTIMONY AND BISMUTH.

Antimony.

The most important source of commercial antimony is the sulphide stibnite ; three oxidised ores, however, occur at times in sufficient quantity to constitute valuable ores. The following is a brief description of these four minerals:—

Stibnite.—Trisulphide of antimony, Sb_2S_3. Antimony, 71 per cent. Coarsely or finely crystallised, massive or granular. Lead coloured and brilliant or iridescent ; opaque. Very soft and easily fusible. G., 4.6.

Kermesite.—Oxysulphide of antimony, Sb_2S_2O. Antimony, 75 per cent. Usually crystallised. Red, opaque, brilliant lustre. Very soft, sectile. G., 4.5.

Valentinite.—Trioxide of antimony, Sb_2O_3. Antimony, 83 per cent. Crystallised or massive, granular. Brilliant lustre ; white, pink, or grey ; translucent. Soft. G., 5.6.

Cervantite.—Tetroxide of antimony Sb_2O_4. Antimony, 79 per cent. Crystallised or massive. Yellow, opaque. Soft, brittle. G., 4.0

Antimony is also obtained as a by-product in the treatment of certain copper and lead ores (fahl ore, etc.).

The first portion of the State in which antimony was discovered was Mallina, in the North-West, where it was discovered in some gold workings. This is the only locality from which antimony ore has been raised for the smelter.

Other localities from which antimony ores have been reported are :—

Division of the State.	Centre.	Nature of occurrence.
North-West	Middle Creek...	Stibnite reported to be abundant in ore from Blue Spec G.M.
Do. ...	Peewah ...	Series of auriferous antimony lodes, some once held as Kate Antimony Lease, M.L. 53, but no ore sold.
Do. ...	Sherlock Crossing	Large bunches of stibnite and cervantite in quartz; 80 acres now held as M.Ls. 86 and 87, Sherlock Antimony Mine. No ore yet exported.
Do. ...	Mt. Magnet ...	Strings and bunches of stibnite and cervantite in auriferous quartz and lodestuff [3426, 3706, 4389], Morning Star G.M.

Other Localities—continued.

Division of the State.	Centre.	Nature of occurrence.
Central ...	Wiluna ...	Masses of stibnite and cervantite in auriferous quartz [1920, 1921.] Assays :—

		Antimony, per cent.	Gold, ozs. per ton.	Silver, ozs. per ton.
[1920]	...	56·0	·65	·25
[1921]	...	58·5	·22	·50

Division of the State.	Centre.	Nature of occurrence.
Do. ...	Kalgoorlie ...	Fahl ore and ruby silver ores in small amount in auriferous lodestuff of Boulder mines [1519, etc.].
South-West	Greenbushes ...	Stibiotantalite with tin ore, *see* p. 106.
Do. ...	Kundip ...	Large bunches of fahl ore in copper lode, Mosaic Mine [5548, 6227].

MALLINA.

M.L. 52, *Mallina Antimony Lease* (40 acres).—The country round Mallina is very flat and broken only by the outcrops of some large buck quartz reefs. The underlying rocks are schists, which form the matrix of the quartz reef in which the antimony ores (stibnite, cervantite, and a little valentinite) occur in bunches. The reef was first opened up in 1888 as a gold mine, but as the payable chute was of very limited extent it was later on abandoned. Early in the present century it was again taken up as an antimony mine, and a shipment of 22 tons of hand-dressed ore, valued for Customs purposes at £230, was sent to England. The proceeds of the sale of this ore failed to cover the expenses of mining and shipment, so that without further work being done the lease was abandoned. Numerous specimens of ore from this mine are in the Geological Museum, see [**4438/9, 5028, 5194/6, 5200**] and [**6500**].

The following are results of assays made of ore composed of stibnite and quartz :—

	Antimony.	Gold.	Silver.
	per cent.	ozs. per ton.	ozs. per ton.
1	30·8	6·70	1·80
2	29·7	trace	?
3	14·9	1·06	?
4	44·4	·44	trace

Bismuth.

There are three chief ores of bismuth, of which the following are descriptions :—

Bismuth (*Native*).—Pure bismuth, 94 to 99 per cent. Opaque, metallic, reddish white to reddish grey. Foliated, massive or granular. Brittle, sectile. Very soft. G., 9.8.

Bismuthinite.—Sulphide of bismuth, Bi_2S_3. Bismuth, 81 per per cent. Sometimes crystallised, usually foliated or fibrous, massive. Metallic, opaque, lead grey. Very soft. G., 6.4.

Bismutite.—Hydrated carbonate of bismuth. Bismuth, 80 per cent. Opaque, earthy, or in crusts. White, yellow, or greenish. Soft. G., 7.0.

The sulphide of bismuth has not so far been recorded from this State, but small quantities of native bismuth, the carbonate and the telluride (tetradymite) occur in various auriferous quartz reefs. No ore has ever been marketed.

The following is a list of the known localities :—

Division of the State.	Centre.	Nature of occurrence.
North-West	Yalgoo ...	Flinty ferruginous quartz with bismuth and bismutite [2292]. Assays—bismuth, 2·61 per cent.; gold, 79·05ozs. per ton; silver, 3·02ozs. per ton.
Central ...	Coolgardie ...	Specks of tetradymite in auriferous quartz, Dunallan G.M.
Do. ...	Burbanks ...	Specks of native bismuth in auriferous quartz, G.M.L. 130, [90].
Do. ...	Lawlers ...	Tetradymite in quartz [3398].
South-West	Ravensthorpe	Specks of tetradymite with gold in quartz, Floater G.M. [4436].

IRON.

Although the iron deposits of West Australia are probably some of the largest in the world, they have, up to the present time, remained absolutely undeveloped, and this is owing entirely to their geographical position and to the non-discovery of suitable coalfields in the State.

So far the only iron worked at all has been that required for use as a flux in copper and lead smelting, and this has been obtained principally from small lateritic deposits handy to the smelters.

Broadly speaking the iron deposits of West Australia fall into two main classes:

(1.) The ores associated with the crystalline schists and other allied rocks.

(2.) The superficial deposits of limonite (laterite ore), which occupy extensive areas in many and widely separated portions of the State, and the soft porous deposits of bog ore of comparatively recent origin.

Ores associated with Crystalline Schists.

The ores of this class—which is by far the most important—are most largely developed in the Murchison district, and the most important deposits are those at the Wilgi Mia (Weld Range) Mounts Hale, Taylor, and Matthews, and Gabanintha. In addition to these places, however, iron-bearing schists are found almost all over the Murchison Goldfields, and at numerous centres in the Pilbara, Peak Hill, East Murchison, Mt. Margaret, North Coolgardie, and Yilgarn Goldfields, in fact, over almost the entire length and breadth of the State, the largest and richest deposits being on the Murchison.

These deposits consist of highly inclined beds, bands and lenses of almost pure hæmatite (or magnetite), or admixtures in all proportions of hæmatite and quartz—usually laminated—and are the result of the chemical alteration of highly foliated and crushed belts of greenstone. They—especially the more siliceous bands—not unfrequently have a width of as much as 10 chains—the average being from half to one chain—and can be followed across country often for many miles.

A full description of the mode of occurrence, etc., of these hæmatite-quartz lodes can be found in Bulletins 14 and 15 of the Geological Survey, where their occurrence on the Murchison and Pilbara Goldfields is dealt with in some detail.

The following is a brief description of some of the richer and more important deposits :—

WILGI MIA (WELD RANGE), MURCHISON GOLDFIELD.

The Wilgi Mia is situated about five miles to the east of the Weld Hercules G.M., and some two miles south-west of Mt. Lulworth, on a ridge running east and west along the south side of the Weld Range. The deposit, which is of almost pure hæmatite, is, roughly, some 150ft. to 200ft. in width, and forms a ridge about three miles in length, rising in places to a height of 400ft. above the surrounding plain. It is of similar origin to the hæmatite bearing quartz lodes which form the main axis of the Weld Range, and which are so prevalent throughout the whole of the Murchison Goldfield, the only difference being that in this case silica is almost entirely absent, and the lode is composed of almost pure hæmatite —with magnetite and limonite—resulting from the gradual replacement of greenstone schists by iron-bearing solutions.

The dip of the lode is very nearly vertical. As sulphides are not likely to be met with above water level—which is about 60ft. below the surface of the plain—it can readily be seen that there is an immense body of ore here; the amount of ore actually in sight above the level of the plain has been roughly estimated at from 26 to 27 million tons.

In addition to this deposit, there is said to be a second similar, though smaller one, about two miles to the north-eastward of Mt. Lulworth. Samples of ore from here appeared to be about the same quality as those obtained from the Wilgi Mia.

These deposits, which are undoubtedly some of the richest in the world, are at present rendered practically valueless owing to their inaccessibility and distance from a suitable coalfield.

The following are partial analyses of three samples of iron ore from the Wilgi Mia deposit, and also one of a sample of the hæmatite-bearing quartz from the Weld Range :—

No.	Metallic Iron.	Silica.	Phosphorus.	Sulphur.	Water. (hygroscopic)	Water (combined).	
1	63·87	2·48	0·090	0·033	0·89	1·52	Per cent.
2	64·36	1·38	0·052	0·028	0·57	0·60	,,
3	68·83	1·00	Trace	0·035	0·19	0·35	,,
4	35·50	43·42	0·089	0·086	0·15	0·17	,,

Traces only of titanium were present.

No. 1 is from what is known as the Little Wilgi Mia, about one and a half miles west of the Wilgi Mia, and on the same lode ;

it represents a sample taken across about 20ft. of the lode at a depth of 15ft. from the surface.

No. 2 is from the Wilgi Mia, and is representative of a sample taken across a face of the lode about 150ft. in width, and at a depth of 100ft. from the surface (*i.e.*, from the top of the ridge).

No. 3 is a picked sample of ore from a surface boulder at the Wilgi Mia ; there are, however, a good many thousand tons of this class of ore lying on the surface.

No. 4 is a typical sample of the hæmatite-bearing quartz lodes which traverse the Weld Range from end to end, and is from a spot about three quarters of a mile west of the Weld Hercules G.M.

It will be seen from the above table that the ore from the Wilgi Mia deposit is of exceedingly high grade, extremely low in sulphur and silica contents, low in phosphorus, and free from titanium.

In addition to this high-grade deposit, there are the hæmatite quartz lodes of the Weld Range, of which No. 4 is a typical example. These, which are in practically inexhaustible quantity, though of rather too low grades for smelting purposes as they now exist, could, with the employment of suitable concentrating machinery, be converted into first-class ores, and during this process of concentration, would doubtless lose a considerable proportion of their phosphorus contents. These remarks also apply to the hæmatite-bearing quartz lodes, which are found in such quantities over the greater portion of the State, of which a typical series of analyses is given below.

With regard to the probability of these deposits living to a depth it may be mentioned that at several places on the Murchison they (the hæmatite quartzite lodes) have been proved at a vertical depth of over 250ft. with apparently no change in their mineral constitution beyond a slightly increased sulphur percentage.

MOUNTS TAYLOR, HALE, AND MATTHEWS.

The sigma-shaped range of hills on the west side of the Murchison, of which Mts. Taylor, Hale, Matthews, and Yarrameedie form the most prominent points, is remarkably prolific in iron-bearing schists. The summit of Mt. Hale is formed of contorted quartz schists with bands of hæmatite which occur in lenticular masses ; some bands are often as thin as a sheet of paper whilst others widen out to considerable dimensions ; one band measures 70ft. across and outcrops for over a quarter of a mile ; it varies somewhat in thickness, however, in different parts. There are other similar parallel bands equally persistent along the strike.

Just under the western summit of Mt. Hale the quartzite is replaced by a great bed of hæmatite, several huge monoliths of which stand out prominently on the range. This bed can be lowed along the range to a point just south of the summit of Mt. Matthews.

An assay of a "grab" sample of this deposit gave a result of 66.6 per cent. of metallic iron.

Table showing results of partial analyses of a series of specimens of hæmatite bearing quartz.

Locality.	District.	Metallic Iron.	Silica.	Phosphorus.	Sulphur.	Water (Hyg).	Water (Combined).
Lake Austin ...	Murchison G.F. ...	39·65	38·42	·068	·042	·12	4·03
Do. ...	Do. ...	42·11	36·38	·106	·054	·14	2·49
Tuckanarra ...	Do. ...	40·55	36·64	·02	·02	·07	4·13
Do. ...	Do. ...	38·15	38·54	·20	·03	·17	3·75
Quinn's ...	Do. ...	29·63	54·15	·078	·034	·08	·60
Nannine ...	Do. ..	31·28	47·48	·312	·030	·28	3·89
Boogardie ...	Do. ...	50·55	24·26	·042	·029	·41	2·94
Do. ...	Do. ...	32·83	52·50	·072	·017	·08	1·33
Do. ..	Do. ...	26·63	61·18	·028	.019	·07	·66
Edjudina ...	North Coolgardie G.F.	37·38	45·05	·04	·032	·17	·49
Do. ...	Do. ...	25·86	60·82	·04	·026	·12	·87
Do. ...	Do. ...	26·69	59·55	·03	·038	·05	·74
Do. ...	Do. ...	33·45	51·76	·04	·034	·11	1·06
Do. ...	Do. ...	38·33	43·10	·06	·024	·12	·93
Do. ...	Do. ...	22·85	61·19	·08	·036	·23	4·24
Southern Cross ...	Yilgarn ...	33·67	50·12	·072	·087	·03	·50
Do. ...	Do. ...	37·04	41·55	.187	·064	·26	3·37
*Parker's Range	Do. ...	60·38	2·93	.038	·068	·44	9·12

* This sample is from the top of Mount Cordan where there is a fair sized deposit of high grade ore, as well as a large quantity of the lower grade, more siliceous variety.

MOUNT NARRYER.

The outcrop of a bed of ironstone forms a conspicuous feature on the surface at the foot of Mt. Narryer Range, this bed is eight to nine feet in thickness, and rises two to three feet above the ground ; numerous other similar parallel beds also occur along the range. An assay of a typical sample of one of these gave results equal to 56.7 per cent. of metallic iron.

GABANINTHA.

About half way between Gabanintha and Star of the East is an extensive deposit of iron ore. In its mode of occurrence this deposit is similar to that at the Wilgi Mia, and to the hæmatite quartz lodes described before.

The lode forms a low ridge running nearly north and south for a distance of about two and a half miles, and having an average height of thirty or forty feet ; its thickness varies from 50ft. to 100ft.—often more—and a very conservative estimate has put the amount of ore actually in sight above the level of the plain as over one and a half million tons.

The ore consists of hæmatite and magnetite, carrying a considerable percentage of titanic acid. A partial analysis of a typical sample shows its composition to be as follows :—Metallic iron, 52.14 per cent.; silica, 0.20 per cent.; phosphorus, 0.008 per cent.; sulphur, nil ; titanic oxide, 12.68 per cent. ; Water (total), 1.30 per cent.

The following table shows the position of the principal Murchison deposits with reference to the nearest Railway Station, and nearest seaport connected therewith :—

Deposit.	Total distance from Seaport.	Distance from Railway.
Wilgi Mia	302 miles Geraldton ...	40 miles Cue
Mt. Hale	390 do. ...	80 miles Nannine
Mt. Narryer	362 do. ...	100 miles Cue
Gabanintha	330 do. ...	20 Nannine

The Superficial Deposits and Bog Ores.

The superficial deposits comprise the laterite ores and the bog iron ores. The laterite ores, together with the gravel resulting from their denudation, are the most widely distributed ores in the State, but unfortunately they vary very much in their composition, ranging from a ferruginous bauxite or claystone to an almost pure limonite or turgite. The ores are most largely developed on the tops of hills or ranges; in depth they pass gradually without any distinct line of demarcation into the underlying rock. The deposits owe their origin to the concentration of ferric oxide resulting from the surface decomposition of rocks rich in iron ; nowhere do they attain any great thickness. The composition of the ores varies considerably, according to the nature of the underlying rocks; when these belong to the basic series (greenstones, diabases, etc.)

ZINC.

The following are the principal commercial ores of zinc and their chief physical properties :—

Blende (*Sphalerite*).—Sulphide of zinc, ZnS. Zinc—57 to 67 per cent. Crystallised or massive, cleavable, granular to compact. Yellow, brown, or black, transparent to opaque. Soft and brittle. Sp. Gr. 4.0. Is the commonest ore of zinc.

Zinkite.—Oxide of zinc. ZnO. Zinc 74 to 80 per cent. Rarely crystallised, usually massive, granular, or foliated. Deep red to orange, translucent. Soft and brittle. Sp. Gr. 5.6.

Smithsonite.—Carbonate of zinc. $ZnCO_3$. Zinc—42 to 52 per cent. Crystallised or massive, granular, or earthy, also stalactitic. White or tinted, translucent. Hard and brittle. Sp. Gr. 4.4.

Willemite.—Silicate of zinc. Zn_2SiO_4. Zinc 48 to 58 per cent. Crystallised, massive, compact, or fibrous. White or tinted, transparent to opaque. Hard and brittle. Sp. Gr. 4.0

As far as official records show, zinc has never been worked in any part of Western Australia. It has, however, been known for many years to occur associated with certain lead ores, especially those of Northampton and Mundijong.

At Northampton, zinc blende has been found in fair quantity associated with the lead ore in the following mines :—(1), Wheal Ellen ; (2), Nooka ; (3), Uga ; and in the case of the Nooka and Uga mines is stated to be present in such quantity that under favourable circumstances it would probably pay to work in conjunction with the lead ores.

An average sample of the ore from the dump on the Nooka mine gave, on analysis in the Geological Survey Laboratory, the following results :—Lead, 12.13 per cent. ; zinc, 18.19 per cent.; copper, 1.04 per cent.; silver, nil. Ore consists of quartz with blende, galena, etc. The zinc blende in this ore is strongly cadmium bearing.

A description of the lead zinc deposit at Mundijong will be found under "Lead," on page 87, where a list of assays of several samples of the ore will also be found. No ore has been treated so far from this property, and it is still in the prospecting stage.

Zinc blende is frequently found in small quantities in the auriferous lodes and quartz reefs throughout almost the whole State. In the Lady Gladys Mine at Mulline it occurs in fair-sized pockets associated with iron pyrites. At Murrin Murrin it is found associated in considerable quantity with the copper ore in the Rio

Tinto Mine, and at Croydon (N.W.) it also occurs associated with copper ores, e.g., in the Evelyn Copper Mines.

Zinc has also been reported as occurring in small quantity at the following places :—

Division.	Centre.	Nature of occurrence.
North-West ...	Yandicoogina ...	Smithsonite with copper ore
Central ...	Kalgoorlie	In small quantities in auriferous quartz reefs
	Coolgardie	do. do. do.
	Laverton	do. do. do.
	Lawlers	do. do. do.
Eucla ...	Norseman	do. do. do.
	Wilson's Patch ...	Small pockets in quartz reef

NICKEL, COBALT, MANGANESE.

Nickel.

No ores of nickel have yet been discovered in this State other than slightly nickeliferous asbolites, although serpentine rocks—their usual matrix—are comparatively abundant. Pyrrhotite (sulphide of iron Fe_7S_8) is an important source of the metal in Canada and Scandinavia, but though this mineral is abundant in many of our sulphide gold ores, notably at Southern Cross, in no instance has much nickel been detected in it.

Cobalt.

Of cobalt ores, asbolite (oxide of manganese, cobalt, etc.) has alone been recognised. This mineral occurs abundantly in parts of the deep leads at Kanowna, principally in the "pug" or bedded kaolin and in the underlying much weathered chlorite schists, from which it has doubtless been originally derived. It is either so thoroughly intermixed with the clay as to be inseparable from it, or else is found in lumps or lining vughs in a soft mammilated form with a bright grey metallic lustre. It occurs also in the nodules of magnesite found at the junction of the "pug" and the adjacent schists, and is frequently studded with minute crystals of gold. A sample of this "pug" carrying asbolite was found on assay to contain:—Cobalt, 7.56 per cent ; copper, .02 per cent.

A similar mineral occurs at Kalgoorlie in veins and impregnations in the oxidised portions of the lodes. A mixture of asbolite and clay from the decomposed schist at the 100ft. level of the Golden Horseshoe Mine yielded on assay:—Cobalt, 3.29 per cent.; copper, .18 per cent.; gold, .16ozs. per ton.

Cobaltiferous asbolite has also been reported from several other localities, notably from Norseman and Greenbushes. A sample from the latter locality gave an assay:—Cobalt, 1.04 per cent. ; nickel, .15 per cent.

As far as recorded none of the above deposits are of sufficient extent to ever render them of any great commercial importance.

Several samples of cobalt and nickel-bearing manganese ores have been sent in to the Departmental Laboratory from the South Coast District for assay and determination, but no detailed information is available as to the nature or extent of the deposits.

The following are the results of the assays of these samples :—

Manganese Ore. 30 miles N.W. of Balladonia.

Loss on ignition	20·17	per cent.
Silica	8·79	,,
Alumina	2·07	,,
Iron Peroxide	1·32	,,
Nickel Oxide	0·31	,,
Cobalt Oxide	0·32	,,
Copper Oxide	0·16	,,
Manganese Oxides	71·86	,,
	100·00	

Manganese Ores. Mt. Barren Ranges.

	I.	II.	III.
Manganese ...	40·15 ...	34·67 ...	41·86 per cent.
Cobalt	0·67 ...	0·41 ...	0·39 ,,
Nickel	0·25 ...	trace ...	trace ,,
Copper	trace ...	trace ...	trace ,,
Silica	15·32 ...	16·25 ...	17·94 ,,
Silver	2dwts. 17grs. ...	2dwts. 8grs. ...	1dwt. 20grs. per ton.

Manganese.

Numerous samples of good-quality manganese ore have from time to time been forwarded to the Departmental Laboratory for determination from various parts of the State, but unfortunately no information is available as to either the nature or the probable extent of the deposits. In addition to the samples referred to above (under cobalt), good specimens of ore have been received from the West Pilbara, from Cue, and from the Phillips River District. The latter deposit, which is on Mt. Decker, is said to be of considerable extent, and likely to prove of some commercial value. Two samples from here gave an assay of the following results :—

No. 1. Massive dense pyrolusite.—Manganese, 48.20 per cent.; iron, 9.80 per cent. ; silica, 2.20 per cent.

No. 2. Soft powdery pyrolusite.—Manganese, 24.41 per cent.; iron, 27.35 per cent. ; silica, 1.76 per cent.

ALUMINIUM.

The principal source of metallic aluminium is bauxite, but corundum, gibbsite, and cryolite are also used as ores to a considerable extent. The chief characters of these minerals are :—

Bauxite.—Hydrate of aluminium, with various proportions of hydrate of iron. $(Al.Fe)_2O_3.2H_2O$. Aluminium, 18 to 39 per cent.; alumina, 35 to 74 per cent. Massive, earthy, or concretionary. Grey, yellow, brown; opaque. Soft or hard. G., 2.5. Occurs very rarely in veins ; commonly in superficial deposits produced by the weathering of crystalline rocks *in situ*, or the collection in lake beds or hollows of the products of denudation.

Corundum.—Oxide of aluminium, Al_2O_3. Aluminium, 53 per cent. The impure variety known as emery contains iron oxide, and is therefore poorer in aluminium. Crystallised, massive, or granular. Grey or tinted, translucent. (The rare transparent highly-coloured varieties are valuable gems, viz., Ruby and Sapphire.) Very hard (9), brittle. G., 4.0 . Found in veins or pockets in crystalline rocks or in river gravels.

Gibbsite.—Hydrate of aluminium; $Al_2O_3.3H_2O$, with sometimes oxide of iron. Aluminium, 32 to 34 per cent. ; alumina, 60 to 65 per cent. Much so-called bauxite is in reality gibbsite, or a mixture of the two. Crystallised, massive, concretionary, or stalactitic. White, grey, yellow, red : translucent or opaque. Soft, tough. G., 2.4.

Cryolite.—Fluoride of aluminium and sodium, Na_3AlF_6 Aluminium, 13 per cent. Crystallised or massive, cleavable. Colourless, white, or tinted, transparent or translucent, glassy lustre. Soft (2½), brittle. G., 3.0. Occurs chiefly in Greenland in a vein in granite.

Of these four ores only bauxite * has been detected in this State. A more or less impure form of this mineral (laterite or ironstone conglomerate) forms very extensive cappings to the Darling and Blackwood Ranges. On the average, this capping is about 6ft. thick, and too much contaminated with iron to constitute a workable ore. It is, however, very extensively used for gravelling roads and footpaths in Perth and elsewhere. From a casual inspection of several gravel pits in the two ranges named, it seems certain that in places the impurities are only very small, and that workable deposits could be located. The laterite is a surface deposit formed *in situ* by the evaporation of the surface of waters rising by capillary attraction during the dry season from the underlying granite, diorite, etc., and charged with the products of their decomposition. The richest lateritic iron ores are therefore to be expected over the numerous intrusive masses of diorite and diabase, whilst the purest aluminium ores must be looked for in those granite areas where the more basic rocks are least developed.

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* *i.e.* Commercial bauxite, including a greater or less admixture of gibbsite with true bauxite.

The following are analyses of laterite, of which the last probably represents the average material, whilst the first is some of the purest bauxite yet observed.

	[3148]	[997]	[1006]
H_2O, Hydroscopic	·58	·58	·69
H_2O, Combined...	24·79	26·44	14·71
Al_2O_3	46·70	44·66	31·14
Fe_2O_3	10·02	19·08	35·54
CaO	trace	trace	·16
MgO	trace	trace	trace
TiO_2	·59	3·10	4·33
SiO_2 (mainly quartz)	17·17	5·96	13·74
SO_3	?	·18	?
P_2O_5	trace	trace	?
	99·95	100·00	100·31
Locality	Smith's Mill.	Wongan Hills.	Mt. Baker.

Mahogany Creek, Mundaring, and Greenbushes have also yielded specimens of the higher grade of bauxite.

TANTALUM.

The two rare metals tantalum and its twin brother, niobium, are nowhere found in the native state or in sulphides or other similar minerals. They exist always in combination with oxygen, and one or more other metals, the oxides having an acid character and giving rise to tantalates and niobates. They invariably occur in conjunction, replacing one another isomorphously to a very variable extent, the niobate of a metal often passing by insensible gradations into the tantalate without change of form or physical characters other than a corresponding gradual rise in specific gravity, tantalum having an atomic weight double that of niobium. In the following pages therefore whenever a mineral is described as a tantalate it must be understood that it contains niobium as well as tantalum, but that the latter is present in preponderating amount, and *vice versa.*

Quite a number of different ores of tantalum have been recorded from various parts of the State, of these the following are brief descriptions :—

Tantalite.—Tantalate of iron, $FeTa_2O_6$. Part of the tantalum is invariably replaced by niobium, and part of the iron by manganese. The variety *Manganotantalite* contains more manganese than iron. Tantalic oxide, 43 to 86 per cent. Crystallised or massive, or in rolled grains. Black, opaque. Hard (6), brittle. G., 6.2 to 8.0.

Columbite.—Niobate of iron, $Fe\,Nb_2O_6$. Part of the niobium is invariably replaced by tantalum and part of the iron by manganese. When the latter metal is in excess the variety is known as *Manganocolumbite.* Tantalic oxide, 1 to 42 per cent. Crystallised or massive, or in rolled grains. Black, opaque. Hard (6), brittle. G., 5.2 to 6.1.

Stibiotantalite.—Tantalate and niobate of antimony, $Sb_2\,(Ta.Nb)_2O_8$. Tantalic oxide, 40 to 55 per cent. Crystallised or massive, or in rolled grains. Grey, yellow, or brown ; semi-translucent to opaque. Soft (5), brittle. G., 6.4 to 7.5.

Microlite.— Tantalate and niobate of calcium, $Ca_2(Ta.Nb)_2O_7$ Tantalic oxide, 60 to 75 per cent. Crystallised or massive, or in rolled grains. Grey, pink, yellow, or brown ; transparent to opaque. Hard (5.5), brittle, but much tougher than other tantalum ores. G., 5.2 to 5.7.

Euxenite.—Titanate, niobate and tantalate of yttrium, erbium, cerium, and uranium. Formula doubtful. Tantalic oxide, trace to 10 per cent. Rarely crystallised, usually massive, also in rolled grains. Brownish black, opaque to semi-translucent. Hard (6.5), brittle.

Tantalum ore has actually been raised for the market at the following localities :—Green's Well, North-West ; Wodgina, North-West ; Mt. Francisco, North-West ; Greenbushes, South-West.

In addition to these localities, tantalum ores have been reported from several other places,* viz. :—

Division of the State.	Centre.	Nature of occurrence.
North-West ...	Moolyella ...	Rolled grains of manganotantalite [5401] and mangano-columbite [7218] in stream tin concentrates.
Do. ...	Cooglegong...	Rolled grains of euxenite in stream tin concentrates [2626] and [7196].
Do. ...	Eleys ...	Large angular detrital fragments of euxenite.
Do. ...	Lalla Rookh (16 miles N. of)	Detrital columbite, mostly well crystallised. An assay gave Ta_2O_5, 4·92 per cent. Nb_2O_5, 70·34 per cent. [6994].
South-West ...	Israelite Bay	Rolled pebbles of tantalite, G. 7·1 and 7·6.

The first discovery of tantalum ore in Australia was that of stibiotantalite in stream tin ore from Greenbushes by Messrs. J. J. East and G. A. Goyder, of Adelaide, in 1893. This mineral had previously been looked upon by the miners as either "resin tin" or scheelite. This mineral threatened at that time to seriously depreciate the value of the Greenbushes tin, owing to its causing a contamination of the latter with antimony.

"In 1900,** at the time when the author (E.S.S.) was examining some of the antimonial tin ores, with a view to suggesting a method of treatment, trouble was again experienced at Greenbushes with a second class of concentrates. Some apparently clean tin concentrates from alluvial ground refused to yield up any tin, either in the assay pot or in the smelting furnace. Several samples of this mysterious ore were forwarded to the author, and proved to be tantalite of the normal iron variety."

In a recent article in the *Mining Journal,* Messrs. F. H. and W. A. Mitchell, the latter Assayer at the Mons Cupri Copper Mine (80 miles from Wodgina), make the following statement with regard to the first discovery of tantalum ore at Wodgina :—

"This mineral was first observed by us in North-West Australia early in 1901, when a crystal was submitted to the British Museum Authorities for confirmation, but it was not until about four years later that we introduced this mineral into Europe for commercial purposes."

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* A complete description of these occurrences as well as a considerable amount of purely scientific detail out of place in this Bulletin is contained in a paper, "Tantalum and Niobium in Australia," read before the Australasian Association for the Advancement of Science, by one of the authors (E.S.S.) in January, 1907, and shortly to be issued in the Transactions of that body. **Loc. cit.

In May, 1904, a black mineral from this locality was forwarded for identification to the Acting Mineralogist and Assayer, Mr. C. G. Gibson, and proved to be manganotantalite, a preliminary analysis showing the presence of 80 per cent. of tantalic and niobic oxides, and 16 per cent. of manganese oxide. At that time there was no market for the mineral, except for museum and other educational purposes, for which the demand was limited to a few pounds per annum. Towards the end of the year, however, the demand which arose in connection with the manufacture of tantalum lamps stimulated prospecting for these minerals.

The Green's Well deposits appear to have been discovered in 1905, those at Mt. Francisco in 1906.

GREEN'S WELL.

The workings in this locality are situated in the same belt of granite as extends from near Lalla Rookh through Wodgina to Mt. Francisco, the original mine is thus described by the Inspector of Mines :—

"On M.L. 100 (? 111 or 112, E.S.S.) O. T. Bell and party,* a rubbly felspar formation (pegmatite vein, E.S.S.) has been exposed for a few feet. This carries tantalite, but sufficient work has not been done to allow of an opinion as to the richness of the lode. On Mr. Beth's alluvial reward claim (? M.L. 105 'Mt. York,' E.S.S.) tantalite can be easily seen in the gully that traverses the claim."

"A sample** of dressed ore from Green's Well brought to Perth by Mr. A. Gibb Maitland apparently consisted of both stream and lode ore in angular fragments from 1mm. up to 20mm. in diameter. A great portion of it is more or less well crystallised, a few excellent crystals being observed in it. . . The sample as a whole assayed: tantallic oxide, 42.39 per cent.; niobic oxide, 21.09 per cent.; metallic tin, 15.62 per cent. The mineral itself varies from a columbite with specific gravity 5.35 to a tantalite with specific gravity 6.84. For the most part it has a dull rusty black surface, but occasional crystals exhibit brilliant black metallic faces. The only associated mineral observed in any abundance is cassiterite. The primary deposit from which the ore is derived appears from the above description to be a typical quartz — albite pegmatite. The ore from Green's Well is characterized by the very variable extent to which tantalum and niobium replace one another. In another sample from here, individual crystals varied in specific gravity from 6.4 up to 7.7, indicating an approximate percentage of tantalic oxide varying from 46 to 81."

The only leases now held in this locality are 105, Mt. York ; 111, Crown ; 112, Central ; 113, Central Extended. Tantalite mining here as elsewhere in the North-West is now practically abandoned owing to the present lack of a market.

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* Geological Survey Bulletin No. 23, p. 68. Perth; By Authority, 1906.

** Tantalum and Niobium in Australia. E. S. Simpson, Australian Association for the Advancement of Science.

WODGINA.

The geology of this field has already been described under Tin on page 56.

Briefly it embraces the line of contact of large masses of greenstone and granite, a belt of schists being developed along the junction, and pegmatite veins passing from the granite into the schists and more solid hornblende rocks. Within the area of the latter the pegmatites contain ores of tantalum, mainly manganotantalite, and it is these veins which constitute the tantalum lodes of the district. Large quantites of detrital ore have been recovered from the shallow surface soil in the immediate vicinity of the outcrops of pegmatite veins. More or less water-worn alluvial ore has also been won from Tantalite Gully, Two-mile Gully, and others in the vicinity. The total output of concentrates to the end of 1906 has been 85.60 tons, valued at £11,569. This has all been won by simple hand-picking or dry-blowing, no crushing plant being in existence on the field. The market for tantalite has been so small and irregular of late that mining for this material is practically at a standstill. Once a steady market were assured it seems probable that Wodgina (including the surrounding district) would be found to be one of the greatest producers of high grade ore in the world.

In the following table are given analyses of—

(*a*) Manganotantalite, large detrital fragment from M.L. 86, "H.M.," Wodgina.

(*b*) Manganotantalite, small rhombic prism, Wodgina District.

(*c*) Microlite, small rolled pebble, Wodgina District.

(*d*) Calciotantalite, small rolled pebble, Wodgina District.

	A	B	C	D
Ta_2O_5	68·65	69·95	77·16	73·88
Nb_2O_5	15·11	14·47		6·44
TiO_2	·40	...	...	·54
SnO_2	·48	·36	present	·72
WO_3	trace	...	...	...
H_2O (combined) ...	·07	...	1·28*	...
FeO	1·63	2·68	3·64	8·42
MnO	14·15	(12·54)	·60	1·39
NiO	trace	...	...	...
CaO	trace	...	13·46	7·78
MgO	·15	...	·42	·62
K_2O	...	...	·20	...
Na_2O	...	...	1·66	...
$(Ce.Y)_2O_3$ ...	*nil*	*nil*	*nil*	*nil*
	100·64	100·00	98·42	99·73
Spec. Grav. ...	7·03	7·09	5·42	6·04
G.S.M. No ...	[6459]	none	[6996]	[6286]

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* Total loss on ignition. Of this, 0·22 % was driven off at 100°.

The mineral which occurs most frequently at Wodgina, and constitutes almost the whole bulk of the ore exported is manganotantalite. A typical fragment from a large specimen of detrital ore was analysed with the results given in column "A." Those in column "B" were obtained from a single rhombic prism weighing 8 grammes. This mineral is black on a fresh fracture, with a metallic lustre. Weathered surfaces are a rusty brown colour, due largely to a thin adherent film of ferruginous clay. In size the masses vary from many pounds in weight down to a few grains only, and in the alluvial are often associated with tin ore, though so far cassiterite has not been recorded from the veins which carry tantalite. The extent to which this ore is intermixed with the stream tantalite is shown by the following assays :—

		Per cent.		Per. cent.		Per cent.
1.	Ta_2O_5	45	Nb_2O_5	32	Sn,	3·12
2.	Do.	60	do.	16	do.	6·74
3.	Do.	17·3	do.	3·5	do.	50·35
4.	Do.	8·9	do.	1·6	do.	60·90

Such mechanical mixtures of the two ores could be readily separated by an electro-magnet.

No normal iron tantalite has been observed at Wodgina, the whole of the mineral there being of the manganese variety. It is usually of a very uniform grade, containing from 65 to 70 per cent. of tantalic oxide. The following assays have been made of lower-grade ore said to be from Wodgina :—

Manganocolumbite—Ta_2O_5, 22·90%; Nb_2O_5, 54·83%; Sp. Gr., 5·72
Manganotantalite— 48·21 30·52 6·34

Microlite (pyrotantalate of lime) occurs in association with manganotantalite in a stream ore received from Wodgina. The exact locality from which this ore was derived has so far not been disclosed, but judging from the associated minerals, it is from the immediate vicinity of Wodgina itself. The mineral, constituting about 2 per cent. of the whole parcel, is in irregular water-worn fragments up to one inch in diameter. The specific gravity varies from 5.37 to 5.76, and colour from light-grey to pink or pale liver colour. It is opaque in mass, but in a thin slice is sufficiently transparent to show that it is isotropic. An incomplete analysis is given in column "C" above.

A few small pebbles received on another occasion from Wodgina had the composition shown in column "D." They are either very intimate mixtures of tantalite and microlite, or else, more probably, a lime variety of tantalite.*

M.L. 86, "*H.M.*" *and M.L.* 87, *Anchorite.*—These two leases are worked in conjunction. They are situated at the north end of

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* For much fuller details of this mineral, see the paper by E. S. Simpson, previously referred to.

Wodgina proper. They are traversed from end to end by a tantalite lode, consisting of a vein of pegmatite composed of very variable proportions of quartz, albite, orthoclase, muscovite, lepidolite, and maganotantalite (6457, 6458). This dyke traverses the greenstones in a north and south direction, and varies from 34ft. to 41ft. in width. On M.L. 87 "not very much work has been done,"[**] operations having been confined to dryblowing the surface along the outcrop and in the vicinity of the "pegmatite vein." This first makes its appearance outside the boundary of the Anchorite ground, to the south of McCarthy's Creek, and after traversing the whole extent of the two properties, extends northward far beyond the limits of the geological map (through M.L. 97, E.S.S.). The vein has been opened up in M.L. 86 for a length of 45ft., but only to a depth of 3ft. or 4ft. To the north of the opencut its width is 41ft., whilst 204ft. further it has dwindled to 34ft...... A considerable amount of dryblowing was being carried out upon the slope of the hill adjoining and to the west of the lode........ Several tons of tantalite, some of it being very coarse (pieces as much as thirty seven pounds being not uncommon), have been obtained in this way.......This detrital tantalite results from the disintegration of the rich chute occurring in the vein adjoining.

The output from these two leases has been :—

1905	... ...	26·00 tons	... £3,425
1906	... ...	8·10 tons	... 2,020
	Totals ...	34·10 tons	£5,445

To this must be added that of Naismith's alluvial claim (Unregistered) which occupied part of the ground now held under M.Ls. 86 and 87.

The output of this claim was :—

1905	...	44·95 tons	... £5,500
1906	...	3·85 ,,	... 385
	Total	48·80	... £5,885

Cassiterite and tantalite occur in conjunction in Two Mile Creek, south of the above workings, whilst Mr. Maitland mentions tantalite as occurring in "lodes" and alluvium for some distance north of M.L. 86.

MT. FRANCISCO.

This locality is about 10 miles south of Wodgina, and has only recently been discovered. According to accounts of the field received in Perth the ore occurs under similar conditions to those which obtain at Wodgina. The lodestuff from the Congo, M.L. 124, is a pegmatite, composed mainly of albite, orthoclase, and quartz, with more or less muscovite and garnet. Manganocolumbite occurs in it in irregular masses, in which parallel groups of crystals are often well defined. A specimen [6975] in the Departmental collection has a specific gravity of 5.73, equal to 23 per cent. of tantalic oxide. A little detrital ore has been also obtained from this locality.

[**] A. Gibb Maitland, G.S. W.A. Bulletin 23. Perth: By Authority, 1906.

GREENBUSHES.

The geological structure of this tinfield has already been described on page 61, under the heading of Tin. The main mass of rock is granite, which is traversed by dykes of diabase and pegmatite. All these rocks are crushed and foliated in places and, except in the lower parts of the valleys, are covered with laterite (ironstone conglomerate).

Two ores of tantalum, tantalite and stibiotantalite, have been worked on this field. Analyses of these are given below:—

	A. [2025]	B.	C.
Ta_2O_5	80·61	51·13	51·95
N_2O_5	2·50	7·36	4·49
SnO_2	1·51	...	...
TiO_2	·71	...	...
SiO_2	...	...	3·14
WO_3	·13	...	...
H_2O combined	·14	...	·61
FeO	10·89	...	...
Fe_2O_3	...	trace	·39
MnO	8·78	...	trace
NiO	·02	·08	trace
CuO	...	...	·20
CaO	*Nil*	...	...
MgO	·19	...	...
Sb_2O_3	*Nil*	40·23	38·04
Bi_2O_3	*Nil*	·82	·79
$(CeY)_2O_3$	*Nil*	...	...
	100·48	99·82	99·61
Sp. gr.	7·74	7·37	6·47
Analyst	E. S. Simpson	G. A. Goyder	G. A. Goyder

Neither of these minerals is by any means common on the fields, to the southern half of which their occurrence is limited. Of the two, tantalite is by far the most plentiful. Tantalite has been found *in situ* in Bunbury Gully, and at the head of the Moulton Brook (Battlers' Gully) in a highly micaceous material [6506, 6375] which is probably the upper portion of an albite pegmatite of the usual type. In these it occurs both in comparatively coarse and very fine pieces, devoid of all crystal faces, but exhibiting an ill-defined cleavage. Chiefly, however, it is known as water-worn pieces from the size of fine shot up to 13lbs. in weight [1917] associated with tin ore in the alluvial deposits of Bunbury and Floyd's Gullies.

Associated with the stream tantalite, but in much smaller and less frequent pieces, is the unique mineral stibiotantalite. It is found at times forming thin veins in tantalite, of which it appears to be an alteration product due to the passage of antimonial solutions through cracks in the parent mineral. It occurs also in waterworn fragments from the size of a pin's head up to about two inches in diameter. Most of these consist of pure yellow or greyish stibiotantalite, but some consist of an ill-defined black core of tantalite surrounded by the pale coloured antimony mineral. It always exhibits more or less definite traces of crystalline structure, one cleavage being usually very distinct.

The recorded output of tantalum ore is very small, viz., 2.46 tons up to the end of 1906. This, however, is probably very far short of the true total of ore raised, many comparatively small parcels of ore never having been reported to the Statist.

M.L. 369, ***Enterprise*** (14¼ acres).—This lease is situated at the head of Bunbury Gully, extending across the main road to Bridgetown. Mr. Campbell, in December, 1905, described this mine in the following terms*:—

"An opencut about 12ft. deep has been made on the west side of the road ; the upper seven feet shows a wash of tin and tantalite [**6507, 6508, 6509**] ; below this is kaolinised gneiss, containing a micaceous lode formation (crushed pegmatite, E.S.S.), 18 inches wide [**6506**], slightly greenish in tint, but in places slightly ferruginous, carrying particles of tantalite and tourmaline from coarse dust to chunks one inch in diameter. A drive has been put in on the lode 30ft. The lode is seen for 18ft., when it tapers out, but the micaceous formation continues and appears to be making again at the end of the drive. The strike of the lode is 323 degrees, and the underlay 22 degrees to the south-west. A shaft about seven feet deep has been commenced a few yards further south to reach this lode further on the underlay. A pot-hole, one and a half chains north-west of the last spot shows a somewhat similar wash [**6508**].

Some large pebbles of alluvial tantalite [**6507**] from this mine are wholly or partially coated with a smooth, hard, and firmly adherent coating of ferruginous bauxite, as much as three or four millimetres thick in places. This peculiarity is shared by the tin ore in other parts of the field. A fair amount of stibiotantalite has been obtained from this mine [**7199**].

Mr. Campbell further states:—**"A little tantalite is said to have been found in wash with tin on the next lease to the north, M.L. 370, Wills, held by Alfred Seabrook, and a claim, No. 755, the Dill-McKay, held by Messrs. Hille & O'Farrell, adjoining the east side of M.L. 369; and also in M.L. 379, Galtee-more, held by Messrs. Marsh and Galt ; this is one mile south-westerly from the

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* Western Australia. Report of the Department of Mines for the year 1905. Perth: By Authority, 1906.

**Loc. cit.

Greenbushes Well Reserve 1381 ; it adjoins part of the south side of M.L. 313, Battlers' Hope." A lode said to carry tantalite as well as tin has been opened up on this lease. It is a kaolinised pegmatite [6375].

The accompanying table shows the total output of tantalum concentrates as reported to the Statist to the Department of Mines, plus an amount of 0.12 tons from Claim 755 at Greenbushes, unreported :—

Production of Tantalum Concentrates.

Year.	Wodgina.		Greenbushes.		Total.	
	Tons.	£	Tons.	£	Tons.	£
1905 ...	70·95	8,925	2·46	1,600	73·41	10,525
1906 ...	14·65	2,644	...	...	14·65	2,644
Totals ...	85·60	11,569	2·46	1,600	88·06	13,169

TUNGSTEN AND MOLYBDENUM.

Tungsten.

Three ores of tungsten are of commercial importance, viz.:—

Wolfram (*Wolframite*).—Tungstate of iron and manganese (Fe.Mn)WO_4. Tungsten, 60 per cent.; tungstic oxide 76 per cent. Massive or crytallised ; well marked cleavage. Hard (5), brittle. Black or dark-brown, opaque, brilliant lustre. G., 7.4.

Huebnerite.—Tungstate of manganese, $MnWO_4$. Tungsten, 60 per cent ; tungstic oxide, 76 per cent. Similar in appearance and properties to wolfram.

Scheelite.—Tungstate of Lime, $CaWO_4$. Tungsten, 64 per cent.; tungstic oxide, 80 per cent. Massive or crystallised. White or slightly tinted yellow, etc.; brilliant lustre, translucent. Hard (5), brittle. G., 6.0.

Of these minerals huebnerite is so far unknown in this State, and wolfram only found in a few localities, but scheelite is present in greater or lesser quantities in many of the gold-bearing quartz reefs in the interior as well as in grains in the alluvial derived from them. In many cases this mineral has been overlooked, but even where recognised no attempt has been made to recover it by concentration except in one instance, viz., at Ravensthorpe, in the Phillips River Goldfield.

The other localities from which tungsten ore has been recorded are :—

Division of the State.	Centre.	Nature of occurrence.
North-West ...	Mosquito	Bunches of scheelite in auriferous quartz reef in Ard Patrick G.M. Assays—*a.* Tungstic oxide, 50·93 per cent.; *b.* Tungstic oxide, 45·10 per cent.; gold, 1dwt. 15gr. per ton. *See* [**6273**].
Do. ...	Roebourne District	[**614.**] Small specimen of wolfram forwarded from Roebourne by prospector; exact locality unknown.
Do. ...	Cue	Scheelite in quartz, Welcome G.M. [**6970**].
South-West ...	Geraldton District	Large crystalline pieces of wolfram in quartz [**5024, 5364**].
Do. ...	Brookton	Wolfram in quartz. *See* below.
Do. ...	West River ...	Masses of scheelite in quartz.

Tungsten Ore Localities—continued.

Division of the State.	Centre.	Nature of occurrence.
Central ...	Southern Cross ...	Large veins and masses of scheelite in quartz from Frazer's G.M. [1414].
Do. ...	Coolgardie	Masses of scheelite carrying coarse gold from reef in Lindsay's G.M. [1299, 4434]. Also as sand in alluvial of Fly Flat
Do. ...	Kalgoorlie	Masses of scheelite in lode stuff in Brown Hill Extended G.M. [3958, 5261]. Also with gold in Hannans Reward G.M. [5945].
Do. ...	Pingin	Small masses of scheelite in quartz, The Oaks G.M. [6348].
Do. ...	Higginsville ...	Large masses of scheelite in quartz in Sons of Erin G.M. [7018] and Sons of Erin North G.M.
Eucla	Norseman	A little scheelite in auriferous quartz, Record G.M. [5960].

BROOKTON.

Early in 1907 a black mineral was sent in from this locality to be determined, and proved to be wolfram. In consequence of the prevailing high price of this mineral (about £120 per ton) several leases were applied for, and Mr. W. D. Campbell, Assistant Geologist, was deputed to inspect the find. He reported, *inter alia* :—

"I have visited the wolfram lode at Mr. Nesbitt's, it is in Location 5868, and adjacent to portion of 6100, on its southern side. It strikes 20 degrees, and underlies east at a high angle. There appear to be two parallel granite lodes with the quartz veins contained in the lease applied for by Mr. Nesbitt. I cannot say what is the exact width of the lode, but about 23ft. were exposed. The surface indications show a poor proportion of wolfram in the lode. The deposit would certainly seem to be worth prospecting on judicious lines."

Several samples of hand-picked ore more or less contaminated with quartz, gave the following assay results :—

L. 2907 ...	Tungstic oxide ...	63·18	per cent.
2927 ...	Do. do. ...	67·47	do.
2930 ...	Do. do. ...	21·19	do.
2957 ...	Do. do. ...	64·72	do.
3026 ...	Do. do. ...	52·05	do.

RAVENSTHORPE.

The geology of this locality has already been discussed under "Copper," page 39. A recent issue (4/5/07) of the *W.A. Mining, Building, and Engineering Journal*, says : —

"A trial parcel of stone from Dallison's Reward, containing gold and scheelite, and treated at the Floater Battery, gave a return of 5ozs. 6dwts. of gold over the plates, and about 22cwt. of concentrates, which have been assayed and gave a return of 66.2 per cent. of tungstic acid."

Molybdenum.

Only two native compounds of Molybdenum are of any commercial importance, viz., the sulphide and oxide. Of these, the former is more common, and is much more readily concentrated. The following are descriptions of these ores:—

Molybdenite.—Sulphide of molybdenum, MoS_2. Molybdenum, 60 per cent. Foliated, scaly or sometimes granular. Metallic, opaque, lead-coloured, closely resembling graphite. Very soft (1 to 1½), flexible. G., 4.7.

Molybdite.—Oxide of molybdenum, MoO_3. Molybdenum, 66 per cent. In fine crystals, fibrous, massive or earthy. Yellow, very soft (1). G., 4.5.

No ores of molybdenum have ever been raised for the market in any part of Western Australia. They are known however to occur in the localities given in the following table:—

Division of the State.	Centre.	Nature of occurrence.
Central ...	Lawlers ...	Molybdenite in quartz [**4855**].
Do. ...	Coolgardie ...	Molybdenite in small albite vein in amphibolite. Ensign G.M. [**387**].
Do. ...	Niagara ...	Molydenite in quartz, G.M.L. 445 [**4396**].
Do. ...	Buldania ...	Molybdenite in greenstone schist [**738**].
Do. ...	Southern Cross	Molybdenite in quartz, at times in excellent crystals.
South-West ...	Blackboy Hill	Small scales of molybdenite in clay [**314**].
Do. ...	Toodyay ...	Numerous large and small flakes in massive grey granite [**6997**].
Do. ...	Clackline ...	Molybdenite and molybdite in quartz [**1316**].
Do. ...	Bedford Haven North of	Molybdenite in quartz.

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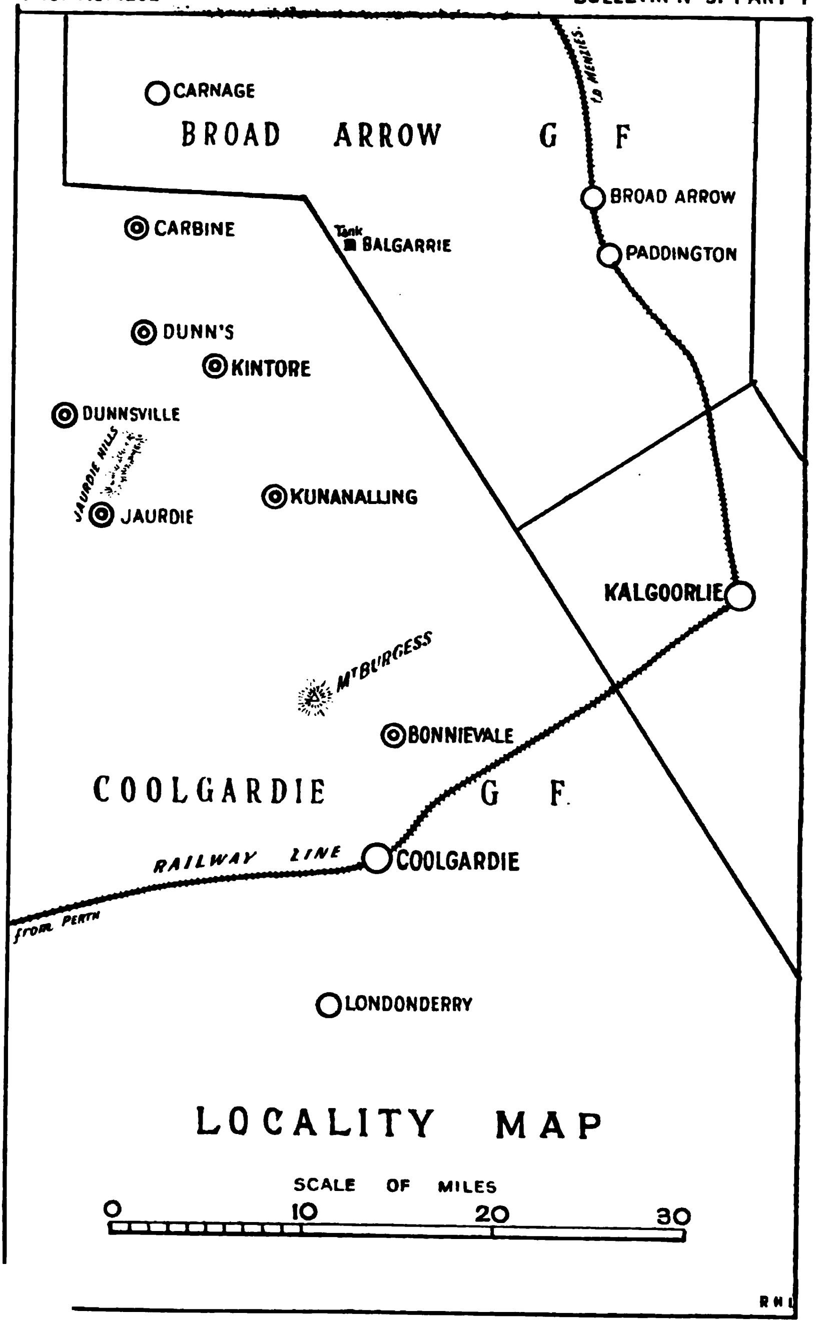

LOCALITY MAP

1908

WESTERN AUSTRALIA.

GEOLOGICAL SURVEY.

BULLETIN No. 31.

PART I.

THE

Bonnievale and Kunanalling Districts,

COOLGARDIE GOLDFIELD.

PART II.

The Black Range District,

EAST MURCHISON GOLDFIELD.

BY

CHAS. G. GIBSON, B.E.,
, Assistant Geologist.

Issued under the Authority of the Hon. H. Gregory, M.L.A.,
Minister for Mines.

WITH MAPS, PLATES, AND FIGURES.

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1908

PART I.

THE
Bonnievale and Kunanalling Districts,
COOLGARDIE GOLDFIELD.

PREFATORY NOTE.

THE various mining centres described by Mr. Gibson in this Bulletin consist largely of fine grained foliated and massive greenstones; these are penetrated by granite which, in some parts of the district, forms the matrix of the principal gold-bearing reefs.

The quartz reefs occur both in the granite and the greenstone, and at times are to be found forming the Junction of the two. The reefs in the granite appear in general to have a strike parallel to the Junction between the granite and the greenstone, and they are invariably hard clean quartz, which carries very little sulphides.

The ore of the highest value is said to be that which is most marked by lamination, and as a rule the hanging walls of the reefs are much better defined than the footwalls.

The Kintore centre is about six miles from Kunanalling and is geologically identical therewith, and is of especial interest by reason of the occurrence of the "Cement Deposits" which filled an old river channel carved out of a much eroded granite. What now remains of this Cement, which appears to have been very extensively worked, occurs everywhere between 1,380 and 1,460 feet above sea level.

The old river channel has been followed by mining operations for over a mile and a-half though there are frequently breaks which may probably be ascribed to erosion; the results of erosion are strongly marked by numerous potholes and deep gutters.

The deposits filling the old water course consisted of rounded and subangular fragments of quartz of all sizes, cemented by a ferruginous silicate of alumina in varying proportions. So far as mining operations have been carried, the payable gold was mainly found in the cementing material. According to the official figures it appears that the cement has yielded 20,217·46 ozs. of fine gold. There seem to be some good scientific reasons for believing th gold to have been deposited mechanically, though a certain quantity may have been added from solution. The ultimate derivation of the gold is from the reefs and formations in the vicinity. The Geological Age of the Cement deposits is somewhat conjectural. but there appears to be some evidence for believing it to be either late Tertiary or Pleistocene.

A. GIBB MAITLAND,
Government Geologist

Geological Survey Office,
17th February, 1908.

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PART I.

The Bonnievale and Kunanalling Districts, Coolgardie Goldfield.

BONNIEVALE.

The township of Bonnievale is situated about seven miles to the north of Coolgardie in a small valley running approximately east and west between two ridges of greenstone hills which rise to a maximum height of two to three hundred feet. The intervening country between this centre and Coolgardie consists of alternating valleys and ridges, these generally speaking having a roughly east and west trend ; a similar class of country also extends eight or ten miles farther north with a difference that a greater extent of flat country exists between the ridges.

The Bonnievale valley has a width—measured from crest to crest of the hills—of about a mile and a-half, and the principal mines are situated about the centre of it, the townsite being just at the foot of the northern rise.

Generally speaking the country may be said to consist of foliated and massive greenstones of the usual type—these being mostly fairly fine grained—and to be a continuation of that greenstone area in which the auriferous deposits of Coolgardie occur. Penetrating these greenstones, however, and occupying the central and western portion of the valley is an area of granitic rocks, and these are of interest in so much as, contrary to usual habit, it is almost entirely within them that the principal gold-bearing reefs are found.

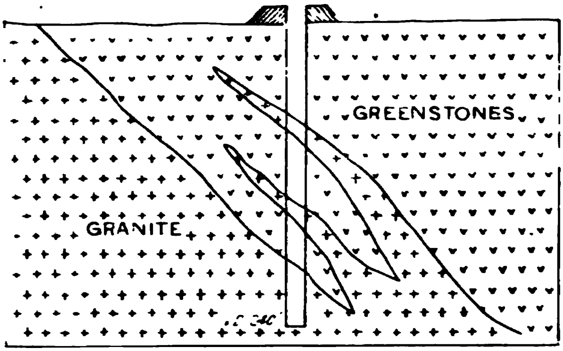
As can be seen by reference to the accompanying map, this granite area has its eastern limit just south of the townsite, and extends westerly for some distance ; its exact extent in this direction is however indeterminable owing to the fact that the whole country to the westward is covered with extensive recent deposits consisting of sand, loam, etc., and being partly the result of the decomposition *in situ* of the underlying rocks and partly the accumulation of debris brought down from the surrounding hills ; owing also to the accumulation of this debris along the lower portions of the valley the absolutely accurate mapping of the geological boundaries in this part is rendered almost impossible ; the effect of this surface debris is, however, somewhat compensated for by the information provided by the various shafts and mine workings.

The greenstones (amphibolites), which appear to be the older rocks, are an uniformly fine-grained variety similar to those found at Coolgardie—which have been described in Bulletin 3 (p. 40) of the Geological Survey—and most other mining centres of Western Australia ; they are for the most part massive, or only slightly foliated, except in close proximity to the granite where they are highly crushed and foliated, the foliation invariably running parallel to the junction with the granite, and in some cases being seen to dip away from it ; this crushing is merely local and only extends over a distance of a few chains from the granite ; it is apparently due to the pressure caused by the intrusion of the latter. One or two small masses of greenstone also occur within the granite area ; these, however, appear to be merely lenticular masses which have been caught up in the granite at the time of its intrusion.

The granite, which as previously stated occupies the central portion of the valley, is fairly coarse grained and massive, showing little or no signs of foliation even along its junction with the greenstones ; it is a biotite variety, fairly light-coloured in hand specimens, and under the microscope the constituent minerals are seen to consist, in addition to quartz, of orthoclase, plagioclase (probably albite) and microline in large flakes and crystals, a few irregular flakes of biotite and a little scattered ilmenite ; the felspars are much clouded, and there is a considerable development of saussurite ; the biotite is a good deal altered into a green chloritic mineral ; a few small grains of apatite are also present throughout the section. No schistosity is noticeable in the section (789) [**7528**].

Where the junction of this granite with the greenstones is plainly visible it can be seen to be dipping below the latter on all sides at a fairly flat angle, and one or two shafts which have been put down in the greenstones a short distance from the junction have bottomed on granite at a comparatively shallow depth ; *e.g.*, on the Westralia Extended, G.M.L. 1639. On the Bendigo, G.M.L. 4096, a vertical shaft started in greenstone is said to have, at a depth of about 230 feet, bottomed on massive granite after first having passed through two narrow dykes of granite, these being apparently offshoots from the main body, thus :—

FIG. I.



Cross Section at Vertical Shaft, Bendigo G.M.L., Bonnievale.

How far this body of granite extends westerly it is hard to say, as about a mile west of the townsite the valley opens out into wide extensive flats covered with a considerable thickness of recent deposits, and no rock outcrops are visible ; it appears probable, however, that it extends out to the south of Mt. Burgess and joins the main mass that lies between Kunanalling and Jourdie Hills.

In addition to the main body of granite there is a still later series of intrusive acidic rocks represented by numerous small felsitic dykes which are found intersecting both the granite and the greenstones ; these vary in thickness from a foot or two to as much as from one to two chains, but are nowhere of any great length or continuity ; the most important of them are shown in position on the map accompanying this report, but there are in addition several other smaller ones in the greenstone hills immediately to the north of the townsite.

The Quartz Reefs.—These are found both in the granite and in the greenstones, and also in a few cases along the line of junction of the two classes of rocks ; these latter, however, have not so far proved to be of much value.

Generally speaking the reefs in the greenstones are small and of no great length, and judging by results—they are all now abandoned—are of very low grade. The most important reef worked in this class of country is that on the Burgess, G.M.L. 4113, about three-quarters of a mile to the north of the town. This reef—as can be seen by reference to the map—is very irregular in its strike, running from nearly south-west to north-west, and dipping at apparently a very flat angle to the northward; near the surface it is of large size, and a good deal of work has been done on it, but it is now abandoned apparently owing to the values decreasing and not to the stone cutting out.

All the reefs now being worked are in the granite, and as a rule they have no regular line of strike, though the more continuous lines generally run approximately parallel to the junction of the granite with the greenstones. On the whole they all appear to be separate fissures or "gashes" and do not appear likely to live to any great depth.

One or two reefs—notably those on the Vale of Coolgardie and Bendigo, G.M.Ls. 1552 and 4096—are for part of their length entirely in granite and for part along the line of contact of the two classes of country, and when this latter happens they are generally smaller and much more irregular.

Although one or two of those reefs which occur wholly within the granite run for a considerable distance, the majority of them are of comparatively short length; they are, however, usually of fair size, but on the whole are very irregular and exhibit a strongly marked lenticular habit frequently pinching out from six or eight feet to as many inches in a short distance and then making again into large bodies just as suddenly; the length and size of these lenses, or "shoots" of stone also varies considerably; so far the average width of the majority of the ore bodies worked, taking them right through, is said to have been about four feet; one or two of them, however, are a good deal below this.

The reefs are invariably of hard clean quartz very white and glassy, and so far carrying very little sulphide; the stone is often strongly laminated, and when this happens the values are said to be better than in the more solid stone; there are no defined shoots of gold, the values being said to be fairly uniform throughout, though as a rule the stone near the wall is generally a little better than that in the centre of the reefs. Frequently the quartz carries a little galena scattered through it, and this is invariably accompanied by higher gold values.

In the upper levels the reefs as a rule have good walls, the hanging wall being usually very clean and regular, while the footwall is not so regular; in the deeper workings the stone in places becomes "frosted" on to the walls and does not come away cleanly.

All the reefs may be classed as low grade, as may be seen by reference to the statistics, but occasional rich patches were found near the surface.

The individual reefs will be found more fully described under the names of the various mines in which they have been worked.

Water Supply.—The district as a whole is only fairly well watered and the supply is invariably salt. For domestic purposes the town depends on the Goldfields Water Supply, to which system it is connected *via* Coolgardie. The supply in the individual mines is not sufficient to keep the batteries going full time, and the Westralia and East Extension which crushes with 40 head of stamps obtains its water from a well on the flat about two miles to the north-west, where there is an abundant supply of salt water.

Timber.—Timber is still fairly plentiful in the district, and consists almost entirely of gum; the best of it has, however, been cut out owing to the fact that the Kurrawong Timber Company's tramway passes a few miles to the north.

THE MINES.

New Victoria Consols (Gem Leases), G.M.Ls. 595, 1405, 1741.

This property on which a good deal of work was done by the original company is now in the hands of a small party of tributors who are doing a little work near the north-east boundary of the block at a depth of about 100 feet. Very little work has been done on the leases for some years past, and the majority of the workings are now inaccessible.

As can be seen by reference to the working plans, the reef was extremely flat, in fact practically horizontal for a great distance, and on this account difficult to work; it is said to have been small and very irregular.

Where the present tributors are working there is only a small block of stone in sight; this even for the few feet it is opened up is very "in and out," varying in thickness from six inches to two feet; there is a small split off it along the but no work has been done on this so far. The stone is hard clean quartz, very white and glassy. The enclosing country is massive granite, much decomposed, and fairly soft throughout the workings.

This line of reef is the one on which the present main workings of the Westralia and East Extension Mines are situated (see page 17).

The plan and section of the workings herewith have been traced from the old company's plans, and are not completely up to date.

Table showing the Yield of the New Victoria Consols Reef.

Year.	Name and Number of Lease.	Ore crushed.	Gold therefrom.	Rate per ton.	Total. Ore crushed.	Total. Gold therefrom	Average rate per ton.
		Tons.	Ozs.	Ozs.	Tons.	Ozs.	Ozs.
Previous to 1897 ..	New Victoria Consols G.M.Co., N.L., G.M. L's. 595 (1401), 1405, 1741	105·00	52·09	·49			
1897 ..	Do.	644·00	541·86	·84			
1898 ..	Do.	3,555·00	1,829·57	·51			
1899 ..	Do.	7,435·00	2,566·38	·34			
1900 ..	Do.	1,270·00	347·77	·27			
1901 ..	Gem Leases, G.M.L's. 595 (1401), 1405, 1741	..	cy. 264·74		13,009·00	5,337·67	·41
1902 ..	Do.	..	cy. 301·19				
1903 ..	Do.	2,020·00	1,648·95	·81			
1904 ..	Do.	2,944·00	2,177·31	·74			
1905 ..	Do.	1,029·00	626·21	·60			
1906 ..	Do.	606·00	438·43	·72			
1907 * ..	Do.	230·00	58·91	·26	6,829·00	5,515·74	·80
	Total	..	..	..	**19,838·00**	**10,853·41**	**·54**

* To 30th June.

Vale of Coolgardie G.Ms. Ltd., G.M.Ls. 1552, 3947.

Not much work is being done on this property, the leases being in the hands of a small party of tributors who at present are doing a little work at the 260 feet level; on the whole very little has been done on the leases for some years past.

Three main lines of reef have been worked, known respectively as the Main Reef, West Reef, and Quarry Reef; the relative positions of these can be seen by reference to the plan herewith. A good deal of work has been done on these reefs, but a great part of the upper workings are inaccessible, and the bottom level was under water and could not be examined.

Most of the work is on the Main Reef, which has been opened up to a depth of 300 feet, this being the deepest work on the leases; at the present time the tributors are working on this reef taking out a block of stone above the 260 feet (intermediate) level; this block averages about four feet in thickness, and this said to have been about the average of the whole reef.

to the north, and cuts across the line of the West Reef but no work has been done on this so far. The stone is hard clean quartz, very white and glassy. The enclosing country is massive granite, much decomposed, and fairly soft throughout the workings.

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		Tons.	Ozs.	Ozs.	Tons.	Ozs.	Ozs.
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1897 ..	Do.	644·00	541·86	·84			
1898 ..	Do.	3,555·00	1,829·57	·51			
1899 ..	Do.	7,435·00	2,566·38	·34			
1900 ..	Do.	1,270·00	347·77	·27	13,009·00	5,337·67	·41
1901 ..	Gem Leases, G.M.L's. 595 (1401), 1405, 1741	..	cy. 264·74				
1902 ..	Do.	..	cy. 301·19				
1903 ..	Do.	2,020·00	1,648·95	·81			
1904 ..	Do.	2,944·00	2,177·31	·74			
1905 ..	Do.	1,029·00	626·21	·60			
1906 ..	Do.	606·00	438·43	·72			
1907* ..	Do.	230·00	58·91	·25	6,829·00	5,515·74	·80
	Total	..	..	..	**19,838·00**	**10,853·41**	**·54**

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[illegible], and cuts across the line of the West

This Main Reef near the surface is along the north-eastern side of a tongue of greenstone, as shown on the map; this tongue, however, dies out at a very shallow depth at its north-western end, but pitches deeper as it goes eastward, and joins the main body of greenstone in this direction; towards the north-western end, where in contact with this greenstone, the reef is said to have been fairly small and very irregular, and to have died out in depth soon after it got away from it; in the present workings farther east, however, it is still going down strongly having granite on both walls, the greenstone having cut out (vertically) as proved by a crosscut to the West Reef, which on the surface is on the opposite side of the tongue; taking this reef right through it is said to have been pretty irregular, sometimes pinching out to a few inches and then again opening out to seven and eight feet; on the whole it is said to have averaged somewhere about 4 feet.

Several other smaller reefs on the north side have been worked in connection with the Main Reef; these were known as the Parallel Reef and the Battery Reef; they were both small and very little work has been done on them; the Battery Reef was only a few inches in thickness, but some nice stone was got out of it; the Parallel Reef was a little larger, but was very low grade. The position of these reefs is shown on the accompanying mine plans.

The West Reef lies about 250 feet south-west of the Main Reef and runs parallel to it; it is entirely in granite, lying a hundred feet or so from the tongue of greenstone which runs alongside the Main Reef. Most of the work on this reef lies between the surface and 100 feet (v.d.), though it has also been opened up at the 300 feet level by a crosscut from the Main Reef; these bottom workings were flooded and therefore inaccessible, and a great portion of the upper workings were also inaccessible owing to the levels having fallen in. No work has been done either on this or the Quarry Reef for some time.

The average thickness of the reef appears to have been from three to four feet, but it is very irregular, and in places goes out to almost a thread; at the south-east end it connects with the Quarry Reef as shown.

The Quarry Reef has been worked to about the same extent as the West Reef, and for the same reasons a great part of the workings are inaccessible.

The reef runs almost due east and west, dipping pretty flat to the north, and cuts across the line of the West Reef diagonally.

The reef possibly marks the line of an old fault, but not sufficient could be seen to make this point clear ; several reefs run into the Quarry Reef, but none of them cut through it, and at the same time it does not appear to cut through them ; all have probably been formed at the same time.

The Quarry Reef is a comparatively short reef, and is more irregular in size than any of the others, frequently pinching out to a few inches, and then rapidly making again to as much as ten and twelve feet in places. At its east end, near where the West Reef comes in contact with it, it runs on to the greenstones and along the junction of these with the granite for a short distance but gets very small and apparently cuts out altogether.

There are several other parallel north-west and south-east reefs uniting with the Quarry Reef on this and the adjoining property, on all of which more or less work has been done. These reefs are one or two chains apart, and are all in the granite, running approximately parallel to its junction with the greenstones, and all dipping at a flat angle to the north-east, the granite also dipping in this direction below the greenstones.

The quartz in all these reefs is hard white and glassy, sometimes strongly laminated and carrying little or no sulphides. The reefs are all low grade, and the values are fairly regular throughout ; in the case of the Main Reef, however, much better values were obtained near the surface at the northern end.

Table showing the Yield from Vale of Coolgardie G.Ms., Ltd.

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
	Tons.	Ozs.	Ozs.
Previous to 1897 ...	166·00	115·85	·69
1897 ...	2,476·00	3,082·50	1·24
1898 ...	2,165·00	1,384·56	·64
1899 ...	11,094·00	6,177·97	·55
1900 ...	11,926·00	7,655·44	·64
1901 ...	12,105·00	5,674·42	·46
1992 ...	11,245·00	4,913·37	·43
1903 ...	9,740·00	4,254·95	·43
1904 ...	3,617·90	1,743·05	·48
1905 ...	3,150·00	1,347·51	·42
1906 ...	2,110·00	898·10	·42
*1907 ...	685·00	117·69	·17
Total ...	**70,479·00**	**37,365·41**	**·53**

* To 30th June.

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Westralia and East Extension Mines Ltd., G.M.Ls. 144, 1151, 1639, 2146, 2266, 3572, 3575, 4012, 4099, 4113, 4114.

This is the only property at Bonnievale on which any work worth speaking of is at present being carried out. A reference to the plan of the underground workings will show that a large amount of work has been done, and that several lines of reef have been opened up; at the present time, however, work is being done on practically only one line, this being the same one as worked on the New Victoria Consols (Gem Leases), and which comes into the Westralia and East's ground at a vertical depth of about 130 feet. Below this depth the reef is a good deal bigger than in the Consol's ground, and is said to have averaged about four feet right through the workings; in the deeper workings on the north side of the shaft there is very little stone, and the reef appears to be cutting out in this direction, though one good-sized lens of stone has been worked; south of the shaft there is a much better reef, which in one place is fully eight feet wide, and probably averages about four feet; in the two bottom levels the stone near the shaft is small, but it is improving in size as the drives are continued southerly.

In addition to this a large amount of work has been done on two other lines of reef known respectively as the South Reef and the Tunnel Reef. Most of these latter workings were inaccessible, but the reefs are stated to have similar characteristics to the main line, being decidedly irregular and lenticular, and to have averaged about four feet in thickness.

There are also several other lines of reef on the leases, on all of which more or less work has been done; these, however, are not considered of any great importance, being of too low grade to pay.

Of these reefs the main largest lines run roughly parallel to the junction line between the granite and the greenstone—here about north-west and south-east—and dip north-east at an angle of about 40 degrees; the second line runs almost due north and south, and the reefs dip at a flat angle to the east; these north and south reefs are, as a rule, shorter and more irregular than the others.

All the reefs are at times strongly laminated, and the quartz is, as a rule, white and glassy, and very free from sulphides; the values are said to be fairly regular throughout, but are distinctly low grade, as can be seen by a reference to the table of returns herewith. In the upper levels the walls are clean and well defined, but in the deeper workings the quartz is becoming "frosted" on to the walls and does not come away cleanly. Occasionally several well-defined separate seams can be seen in the one reef, apparently as if several depositions of quartz had taken place, and when this happens it is said that usually only alternate seams carry values.

The country rock is a massive granite, fairly soft in the upper levels, but very hard and compact in the bottom workings.

The mine water is salt and the supply is limited ; water for battery purposes is obtained from a well on the flat about two miles to the north-west, where an abundant supply (salt) is obtainable.

The mine is equipped with an up-to-date 40-head mill and plant.

Table showing the Yield from the Westralia and East Extension Mines, Ltd.

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
	Tons.	Ozs.	Ozs.
Previous to 1897 ..	232·00	92·54	·39
1897 ...	7,555·10	7144·43	·94
1898 ...	22,615·35	11,923·55	·52
1899 ...	9,326·20	2811·41	·30
1900 ...	495·00	80·37	·16
1901 ...	4,282·00	1,453·25	·33
1902 ...	13,149 00	9,433·21	·71
1903 ...	26,981·00	19,823·10	·73
1904 ...	26,388·90	16,482·23	·62
1905 ...	31,688·00	13,680·38	·43
1906 ...	40,115·09	14,875·74	·37
*1907 ...	15,299·00	5,261·09	·35
Total ...	**198,125·65**	**103,061·30**	**·52**

* To 30th June.

Table showing the Yield from Leases at Bonnievale, other than those already mentioned, up to 30th June, 1907.

Name and No. of Lease.	Ore crushed.	Gold therefrom.	Rate per ton.
	Tons.	Ozs.	Ozs.
Bendigo and Coolgardie Prop. Co., N.L., G.M.Ls. 3847, 3848, 4096, (126, 347)	3,891·00	3,411·86	·87
Black Cat, G.M.L. 4174 ...	61·00	35·62	·58
Condenser King, G.M.L. 3602 ...	306·50	214·85	·70

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Table showing the Yield from Leases at Bonnievale, other than those already mentioned, up to 30th June, 1907—continued.

Name and No. of Lease.	Ore crushed.	Gold therefrom.	Rate per ton.
	Tons.	Ozs.	Ozs.
Curiosity, G.M.L. 3869... ...	117·00	37·31	·31
Enterprise, G.M.L. 3901 ...	178·00	138·97	·78
Gem of the Vale, G.M.L. 3630 ...	44·10	12·03	·27
Gentle Annie, G.M.L. 3805 ...	809·50	1,292·42	1·59
Golden King, G.M.L. 1811 ...	47·00	47·09	1·00
Lady Florence, G.M.L. 3742 ...	62·50	47·34	·75
Little Victoria, G.M.L. 3895 ...	20·00	29·55	1·47
Mt. Burgess G.M., Ltd., G.M.Ls. 2413, 1610...	8,434·50	8,463·25	1·00
Mt. Burgess Christmas Gift, G.M.L 1610	427·00	252·76	·59
Mt. Minyen, G.M.L. 3923 ...	32·00	12·94	·40
Native Wonder, G.M.L. 3763 ...	25·00	15·86	·63
New Burgess, G.M.L. 3944 ...	42·50	8·01	·18
North Burgess, G.M.L. 4060 (1610)	...	cy. 185·17	
North Burgess G.M. Co., Ltd., G.M.L. 1610	1,037·00	617·66	·59
Prim Syndicate, Ltd, G.M.L. 2638	2,684·80	2,052·47	·76
Prince Llewellyn, G.M.L. 3829 ...	68·00	17·26	·25
Water Trust, Mining and Public Crushing Co. of W.A, Ltd., G.M.L. 3453	1,648·30	808·35	·49
Sundry Claims	245·50	153·44	·62

Bonnievale to Kunanalling.

North from Bonnievale the greenstone country extends for about nine miles, being mostly covered with recent deposits, with only occasional rock outcrops in the form of low ridges; it then gives place to massive granite, which extends continuously, with occasional outcroppings from beneath the sandy covering of recent deposits, to Kunanalling.

The southern junction of this granite with the greenstones is not visible, but it probably runs a little north of west and south of east; the northern junction runs about north-west and south-east through the townsite of Kunanalling (*vide* map). To the westward this body of granite appears to open out over a very considerable area, but to the eastward it does not appear to be so extensive.

KUNANALLING.

The townsite of Kunanalling is situated at the south-western foot of a low ridge of greenstone hills, extending in a general north-westerly and south-easterly direction, and having a maximum height of 150 to 200 feet; to the south and west the whole country is flat and covered with loose sandy soil and fairly heavily timbered with mulga and gum; to the north, immediately behind the town, are a few low parallel greenstone ridges trending roughly north-west and south-east for four or five miles and having a maximum width of about a mile and a-half, then giving place to extensive mulga and salt-bush flats.

Broadly speaking the rocks of the district can be said to consist of only two classes, viz., granite and greenstone, the junction of which runs approximately north-west and south-east through the middle of the town; the country to the south and west is granitic, and to the north and east is greenstone.

The general line of this eastern boundary of the granite is shown on the map herewith; its western boundary is about a mile on the Kunanalling side of the Jourdie Hills Trig., and apparently runs much more nearly north and south; beyond the western limits of the map the eastern boundary swings round a good deal more westerly running several miles to the south of Dunn's Eight Mile; the western edge is said to be about two miles to the east of Dunnsville, so that the belt is getting much narrower in this direction, and possibly dies out altogether a few miles farther north. Southerly and south-westerly this granite belt opens out into a large area lying between Jourdie Hills and Coolgardie, its extent however in this direction is not exactly known.

In addition to this main body of granite there are one or two smaller areas within the district examined, between Kunanalling and Kintore; these occur entirely within the greenstones and at no great distance from the main granite mass; their position and extent are shown on the map herewith. Owing to the recent deposits which cover the greater portion of the country between Kunanalling and Kintore the exact boundaries of these smaller granite bodies are difficult to exactly define; they are evidently offshoots from the main mass.

The granite is a massive variety similar in hand specimens to that at Bonnievale, and is undoubtedly intrusive through the greenstones. A section (788) of a specimen [7523] taken from the water shaft on G.M.L. 734s at Kintore shows it to differ slightly from the Bonnievale variety in that the felspar consists almost entirely of orthoclase in large flakes and crystals generally exhibiting zonal structure and Carlsbad twinning; a little plagioclase is also present, but microline is apparently entirely absent; the biotite is not so altered but where so is changed into colorless scaly talc; the felspars are very little altered; more ilmenite is present, and is largely altered into leucoxene. The section shows no sign of schistose structure.

The greenstones are of the type usually found on the Eastern Goldfields of Western Australia, and occur both massive and schistose.

The schistose rocks are most largely developed in immediate proximity to the granite, and apparently owe their existence to the presence of the latter; they only extend over a width of from, roughly, ten to fifteen chains, occasionally more, the schistosity is invariably parallel to the junction with the granite and dips away from it; it is most strongly developed closest to the junction. These schistose rocks pass imperceptibly into the massive and slightly-foliated variety, and are merely a crushed form of the same.

Running through these massive and foliated rocks are occasional narrow bands of schists, having a trend invariably parallel to the granite junction; these bands are often less than a chain in width but are usually fairly continuous, evidently marking shearing or faulting planes; it is within these that the majority of the payable ore bodies have been found.

The massive greenstones, as a rule, form the ridges, while the schist belts are found in the valleys between, which probably owe their existence to the softer and more-easily weathered schists. They, the massive varieties, are fine grained and very hard and compact at a depth. A section (785) of a specimen [**7519**] taken from the dump on Pearce's Find, G.M.L. 2836, shows it to consist of an intimate mixture of pale green hornblende (actinolite) and a plagioclase felspar (probably labradorite) in about equal proportions, the latter sometimes showing slight signs of crystalline boundaries, but being, as a rule, in irregular masses and showing very little clouding or alteration; a good deal of magnetite is also present in the form of skeleton crystal aggregates; no schistose structure is visible in this section.

In addition to the granite and greenstones there is a series of acidic dykes which are found traversing the greenstones. These are usually small, being sometimes only three or four feet in width and of no great length, and have not been shown on the map, as the scale of it is too small to permit of them being delineated with any degree of accuracy. These dykes are not numerous, and when found are usually in fairly close proximity to the granite. Some of them closely resemble the main body of the granite, from which they appear to be merely off-shoots; others appear to belong to a later intrusion, and consist of fine-grained felsites and quartz porphyries. These have mostly been met with in the workings below ground (*e.g*, in the Premier Extended, G M.L. 419), and are not as a rule visible on the surface. This is owing to the recent deposits which cover the greater part of the district under examination, and if these were removed the granitic and porphyry dykes would probably be found to occur in considerable numbers. One or two of these granitic dykes occurring along the line of the schist belts mentioned above have been found to exhibit a strongly-marked schistose structure parallel to the schistosity of the greenstones, having evidently been subjected to the same shearing action as the latter, this shearing having taken place subsequent to the granitic intrusion.

Quartz Reefs and Lodes.—The auriferous quartz reefs and lodes of Kunanalling are found almost without exception in the greenstones, thus conforming to the usual West Australian rule A number of quartz reefs occur along the junction of the granite with the greenstones, these sometimes being of considerable width but of little length, and so far have not proved to be gold-bearing.

The auriferous quartz reefs on the whole are small, and though the channels in which they have been formed are often of considerable length, the actual reefs, or quartz bodies, are of uncertain length and very irregular.

By reference to the accompanying map it will be seen that with one notable exception (the Emu-Broncho line) the reefs all run approximately north-west and south-east, and maintain a marked parallelism to the junction between the granite and the greenstones; morever it will be seen that the majority of them are found along one main line about half a mile distant from this junction. This line will be known as the "Main" or "Premier" line. Lying between it and the granite is a second well-defined parallel, but apparently much shorter, line known as the Shamrock line. Both these lines are bands of schist within which ore bodies occur.

The Main or Premier line, as can be seen by reference to the map, is a well-marked continuous line from the Inkerman (Ruby May) at the north, south-easterly through Bows Gold Mine, the Brilliant, the Catherwood, and the Premier, a distance of nearly two and a-half miles. A little to the south-east of the Premier the outcrops disappear for a distance of about half a mile beneath extensive flats What is, however, probably the continuation of the line has been worked on the Waratah and General Buller leases, and again farther south-east on the Blue Bell, a total distance of nearly four miles South-easterly between the Blue Bell and the Golden Fremantle the country for a mile or so is more broken, consisting of low irregular ridges of massive and slightly-foliated greenstone, and there are no regular defined lines of reef through it. Farther south, however, through the Golden Fremantle, New Fremantle, and Star of Fremantle, there is another continuous well-defined line, which may possibly be the continuation of the Premier line.

The Shamrock line has nothing like the same continuity as the Premier, but has been proved for a little over half a mile, and probably extends a good deal farther than this, as it is hidden at either end beneath extensive areas of recent deposits.

Eastward of the Premier line nothing of importance has so far been found, partly because the greater part of the country is covered with recent deposits, and partly because the greenstones in this direction are mostly massive, and what reefs do occur in them are small and of little length and no regularity.

Along these two principal lines ore bodies of varying length and width occur, the most important of which has been that worked on the Premier, G.M.L. 79s. These ore bodies consist of lenticular bodies of quartz occurring singly, sometimes of considerable size and length, and in series, when they form practically one continuous quartz reef; sometimes several parallel bodies occur along the same line, and on this account more cross-cutting than has been done in most of the mines would have probably proved beneficial.

The quartz lenses, or series of lenses, occur usually within a well-defined body of greenstone schist, which still continues after the quartz has cut out, but unfortunately though the values in the quartz are often high those in the schist are not rich enough to pay. Generally speaking the ore bodies can be said to be small.

So far the work done in the district has gone to show that these ore bodies do not live to any depth, usually dying out at from 100 to 150 feet, and up to the present any deeper work that has been done has not proved the recurrence in depth of other payable ore bodies.

The various individual reefs and ore bodies will be found most fully described under the names of the leases on which they have been worked.

Water Supply.—The water supply of the district invariably salt, and for domestic purposes the residents have depend principally on the Government dam, which so far h proved sufficient for all requirements. The supply of salt wat in the mines varies considerably, but the various batteries ha had no difficulty in obtaining a completely adequate supply.

Timber.—Timber (gum and mulga) of good quality is s plentiful throughout the district.

THE MINES.

Premier, G.M.Ls. 79s, etc.

This mine was at one time the mainstay of the district, b it is now almost abandoned, and the surface plant has be practically all removed to other localities. A reference to t mine plans (Plate IV.) will show the amount of work that h been done.

Three separate ore bodies have been worked, kno respectively as the West, Middle, and East. The West a East bodies run nearly parallel, but the Middle one runs mo easterly and forms a connecting body between the other two.

Both the East and the Middle bodies start some distan north of the main shaft and run northerly. Both of them, mo especially the East, pitch at a very flat angle to the north. T West body is the main one, and it has been worked both nor and south of the main shaft for a total distance of about 9 feet.

These ore bodies consist of long lenticular masses of quar and occur within a well-defined belt of greenstone schist trendi about north-east at an angle of from 50 to 60 degrees. Althou of considerable length they are of no depth, the West body havi cut out at about 80 feet and the East at just below the 140 fe level. Below these depths the place of the quartz is taken b highly altered and partly-graphitic schist sometimes carryin thin seams of quartz, and though the workings have been carrie down to a depth of 300 feet there is no change and no signs o other quartz bodies coming in. With the quartz the payabl gold values have also gone, for although the schist carries a littl gold it is of too low grade to pay for working.

With the exception of a little crosscutting and development work near the surface very little has been done on the leases for some time past, and the greater part of the workings are inaccessible; the upper workings on account of the levels having fallen in, and the bottom because the water is up.

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The size of the ore bodies appears to have varied a good deal, but to have averaged from two to four feet. At the north end of the 140 feet level there is a large body of quartz going down underfoot, but carrying very low values, this being the end of the East shoot. Development at a lower level has proved this body to cut out a little below the 140 feet. Crosscuts from the upper levels have been put in each way to the massive greenstones forming the walls of the belt of schist, and have failed to reveal anything in the way of other parallel ore bodies, and the chances of finding anything by further sinking appear to me to be very remote.

The mine was originally equipped with a 20-head mill, but this and most of the other surface plant has been removed, and it is in a very deserted looking state.

The water supply, which was salt, was not good, and water for milling purposes was obtained from a well near the edge of a small salt lake some three miles to the south.

Table showing the Yield of the Premier Group.

Year.	Name and Number of Lease.	Ore crushed.	Gold therefrom.	Rate per ton.	Total.		Average rate per ton.
					Ore crushed.	Gold therefrom	
		Tons.	Ozs.	Ozs.	Tons.	Ozs.	Ozs.
Previous to 1897 ..	Premier South* G.M.L. 74s	19·00	9·91	·52			
1897 ..	Do.	50·00	100·50	2·01			
1898 ..	Do.	813·00	248·54	·30			
1900 ..	Do.	100·00	129·62	1·29			
1901 ..	Do.	12·00	5·12	·40	994·00	493·69	·49
Previous to 1897 ..	Premier G.M. Co., N.L., G.M.Ls. 79s, 111s, (70s, 74s, 436s, 278s)	3,141·00	5,680·42	1·80			
1897 ..	Do.	4,358·00	4,470·38	1·02			
1898 ..	Do.	9,085·00	5,383·18	·59			
1899 ..	Do.	11,189·00	5,895·57	·52			
1900 ..	Do.	15,649·00	10,144·30	·64			
1901 ..	Do.	10,710·00	3,740·43	·34			
1902 ..	Do.	2,302·00	4,872·36	2·11			
1903 ..	Do.	3,371·50	3,056·34	·90			
1904 ..	Do.	1,506·50	946·34	·62			
1905 ..	Do.	604·50	2,358·37	3·90			
1906 ..	Do.	185·50	196·71	1·06			
1907† ..	Do.	..	cy. 114·80	..	62,102·00	46,859·20	·75
1898 ..	Emu‡ G.M.L. 111s ..	102·00	138·25	1·35			
1899 ..	Do.	41·00	28·76	·70			
1906 ..	Do.	133·35	34·95	·26	276·35	201·96	·73
	Total	..	..	..	63,372·35	47,554·85	·75

* Transferred to Premier. † To 30th June. ‡ Amalgamated with Premier G.M. Co. in 1902, transferred again in 1906.

Blue Bell, G.M.L. 696s.

On this lease several small quartz veins have been worked to a depth of 150 feet. These occur in a belt of greenstone schist, which is probably a continuation of the Premier line. They are

20 to 30 feet apart, and run almost due north-west and south-east, dipping at an angle of about 80 degrees to the north-east. Most of the work has been done on the most easterly vein, and this has been opened up for nearly the whole length of the lease, and a lot of work has been done on it down to 100 feet. A little work has also been done down to 150 feet, but nothing below this as the country is getting hard, and the stone here is too small and too poor to pay. All the veins are small and irregular, the main one, averaging not more than six inches in thickness, is said to have occasionally reached as much as 30 inches, but this only for a short distance. One or two rich pockets were obtained from this vein, but generally speaking the values have been fairly regular right through.

On the adjoining lease (Blue Bell Extended, G.M.L. 727s) a good deal of work has been done on a similar parallel quartz leader, but the workings have been abandoned for some time and were inaccessible.

A good supply of salt water was struck in the main shaft on this lease, the water commencing to make at about 125 feet.

The property is equipped with a five-head battery with which the owners, in addition to treating their own stone, do a good deal of public crushing.

Table showing the Yield of the Blue Bell Leases.

Year.	Name and Number of Lease.	Ore crushed.	Gold therefrom.	Rate per ton.	Total.		Average rate per ton.
					Ore crushed.	Gold therefrom.	
		Tons.	Ozs.	Ozs.	Tons.	Ozs.	Ozs.
Previous to 1900 ..	Lone Hand G.Ms., Ltd., G.M.Ls. 1s, 6s	..	..	..	217·70	123·39	·56
Do. ..	Phœnix G.M., Ltd., G.M.L. 1s	..	..	..	635·50	348·40	·54
1900 ..	Lone Hand, G.M.L. 539s, (6s)	112·00	113·64	1·01	357·00	327·71	·91
1901 ..	Do.	225·00	199·75	·88			
1902 ..	Do.	20·00	14·32	·71			
1903 ..	Blue Bell, G.M.L. 696s	137·00	127·79	·93	697·00	437·52	·62
1904 ..	Do.	224·00	118·71	·53			
1905 ..	Do.	336·00	191·02	·56			
1904 ..	Blue Bell Extended, G.M.L. 727s	17·00	8·39	·49	113·00	71·32	·63
1905 ..	Do.	96·00	62·93	·65			
1905 ..	Blue Bell Leases, 696s, 727s	40·00	15·40	·38	810·00	458·46	·56
1906 ..	Do.	592·00	332·26	·56			
1907* ..	Do.	178·00	110·80	·62			
	Total	..	..	..	2,830·20	1,766·80	·62

* To 30th June.

Waratah and General Buller, G.M.Ls. 616s, 626s.

These leases are situated about midway between the Blue Bell and Premier on what is apparently the same line. A good deal of work has been done, but the leases are now abandoned. Several lines of reef have been opened up, these occurring in a narrow belt of greenstone schist, and being apparently similar to those on the Blue Bell. They run about north-west and south-east, dipping at a steep angle to the north-east, and appear to have been of fair size in places. A fairly continuous make of stone was opened up, but all values are said to have cut out a little below the 100 feet level. A plentiful supply of salt water was struck at a depth of 150 feet.

(For returns, see table page 35)

Catherwood Leases, G.M.L. 656s, 657s (Bow's Leases).

A good deal of work has been done on these leases, but apparently without satisfactory results, and they are now idle. The workings are on a narrow belt of schist, probably a continuation of the Premier line, and the ore bodies most likely consisted of the usual irregular lenticular quartz veins, and were evidently of no size or continuity. On the dump of a vertical shaft on G.M.L. 657 can be seen pieces of a dark-coloured highly-altered greenstone schist slightly graphitic and carrying small seams of quartz and calcite, being exactly similar to that met with at the 200 feet level in the Premier. This shaft has apparently passed through a belt of this schist, but as was the case in the Premier the values were no good.

The country on either side of the schist belt consists of massive and slightly-foliated greenstone, and judging by the dumps at one or two of the shafts gets very hard at a comparatively shallow depth.

A plentiful supply of salt water was met with in the main shaft on G M.L. 656s, and the water for the Government subsidised battery (Bow's Battery) is obtained from this shaft.

Bow's Leases, G.M.Ls. 646s, etc.

These leases are on the continuation of the Premier-Catherwood line, and a lot of work has been done on them to a shallow depth. There are said to have been several small parallel makes of stone occurring in a belt of schist, which is enclosed in massive to slightly foliated greenstone, and runs about north-west and south-east, dipping pretty flat to the north-east.

No work is being done on the leases at the present time, and most of the workings are inaccessible.

The ore bodies apparently consisted of a series of small irregular quartz lenses, and are said to have cut out completely at a vertical depth of about 50 feet. A little work has been done at a considerably greater depth than this, but apparently without result.

There is a 10-head battery on the property which crushes for the public, and at the present time is subsidised by the Government.

Table showing the Yield of Bow's Leases.

Year.	Name and Number of Lease.	Ore crushed.	Gold therefrom.	Rate per ton.	Total.		Average rate per ton.
					Ore crushed.	Gold therefrom.	
		Tons.	Ozs.	Ozs.	Tons.	Ozs.	Ozs.
Previous to 1900 ..	Blackett's G.Ms., Ltd.. G.M.Ls. 28s, 71s, 162s	..	..	..	4,461·25	2,705·77	·60
1900 ..	Catherwood G.Ms., Ltd., G.M.Ls. 511-3s, 522s	..	..	..	38·00	11·85	·31
1901 ..	Amalgamated G.Ms., Ltd., G.M.Ls. 646-9s, (28s, 71s, 162s), 522s, 599s, 604s, 650-1s, 656-7s	230·00	330·25	1·43	2,019·30	1,471·90	·72
1902 ..	Do.	164·00	154·98	·94			
1903 ..	Do.	1,150·65	792·49	·69			
1904 ..	Do.	474·65	194·18	·40			
1905 ..	Bow's Leases, G.M.Ls 646s, 656-7s	845·50	309·40	·36	2,056·59	468·29	·22
1906 ..	Do.	852·00	96·26	·11			
1907* ..	Do.	359·09	62·63	·17			
	Total	..	..	..	**8,575·14**	**4,657·81**	**·54**

* To 30th June.

Inkerman, G.M.L. 757s (Ruby May, G.M.L 599s).

This property is on the extreme northern end of the apparent continuation of the Premier line. The ore bodies are of the usual type of the district, viz., small irregular lenticular quartz reefs occurring in a narrow belt of greenstone schist enclosed in massive to slightly foliated greenstone. The present workings are at the extreme north end of the lease where two parallel ore bodies some 20 feet apart have been opened up. Other makes of stone occur farther south and between this lease and Bow's, but so far they have not proved of any value, and very little work has been done on them.

At the present time the owners are working at the 100 feet (water) level and between this and the surface. A little work was done at the 150 feet level by the previous owners, but the workings were inaccessible. Apparently the results were not satisfactory. Most of the work is on the more western of the two makes of stone at the north end, very little having been done on the other. This western make is very irregular, ranging from a mere thread of quartz to bunches up to nearly three feet in thickness. Its average throughout the present workings is from eight to ten inches. Very good values are being obtained, and they are said to be still good along the bottom of the main drive (100 feet level). The gold is mostly fine, and a lot of it occurs in vughs left by the oxidation and leaching out of sulphides in the stone. These sulphides are fairly plentiful along the bottom level, and will probably be found to be pretty heavy below water. Only the quartz carries payable values. There is a little gold in the schists, but not sufficient to pay to work.

Table showing the Yield from the Inkerman Lease.

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
	Tons.	Ozs.	Ozs.
1905	15·00	8·28	·55
1906	188·00	219·86	1·17
1907*	205·00	345·12	1·69
Total	**408·00**	**573·26**	**1·40**

* To 30th June.

Emu and Broncho, G.M.Ls. 111s, 458s.

The reefs on these two adjoining properties form a notable exception to the general rule of the district. Several lines have been opened up, and these strike about north-east and south-west, or directly at right angles to the main lines and to the granite junction. Their dip is at a fairly flat angle to the south-east. The country here is a hard tight greenstone exhibiting slight foliation in the normal direction, *i.e.*, north-west and south-east, and in addition a well-marked foliation at right angles to this. This cross foliation extends over a width of about ten chains and a length of from twenty to thirty chains.

The reefs, which run parallel to the cross foliation, are short, having a maximum length of some five chains, and small, apparently having an average width of about two feet. They are of hard white quartz, and judging by results are mostly of little or no value. A good deal of work has been done on several of them, but they are all now abandoned. On the Emu one of them has been worked to a depth of a little over 300 feet on the underlay. The shoot of gold is said to have been fairly rich but very short—merely a pipe—and the country being extremely hard it would not pay to work further.

The returns from the Emu are included under the Premier (*see* page 25), and those from the Broncho are shown on page 35.

Star of Fremantle, G.M.L. 645s (609s).

A well-defined line of reef runs through this lease and the adjoining ones to the northward, and a good deal of work has been done on it in various places. The general trend of the line is a little west of north-west, and its dip is about 80 degrees to the north-east. On the Star of Fremantle it has been worked to a depth of 260 feet The water was up in these workings at the time of my visit, and they were therefore inaccessible. Mr. Crabb, Inspector of Mines, has reported on the mine as follows:— "The lode has been opened up to a depth of 260 feet. At the 250 feet a level has been put in north 30 feet and south 40 feet. At 200 feet the lode has been driven along for 170 feet, and this block stoped out to the surface. Along the 200 feet level the lode averaged about three feet in width, but along the 250 feet it has pinched to about six inches. Throughout the upper workings the reef varies from a few inches up to 8 feet, and may be said to have averaged about three feet."

In addition to this work a good deal has been done above the 100 feet level.

The ore body consists of an irregular lenticular quartz reef occurring in a narrow belt of greenstone schist.

On the adjoining block to the northward (Fremantle Vale, G.M.L. 618s) there are two well-defined parallel makes of stone at the surface. These are 20 to 30 feet apart, and appear to be from two to three feet in width. A good deal of work has been done on the more eastern make down to 100 feet. The main shaft has been carried down another 100 feet, but there are said to have been no values below 100 feet. A good supply of salt water was struck in this shaft at a depth of 200 feet.

Both this lease and the next one farther north (New Fremantle) on which a lot of work has been done down to 100 feet on the same line of reef, are now (August, 1907) abandoned, and the workings are inaccessible.

Table showing the Yield from the Star of Fremantle Lease.

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
	Tons.	Ozs.	Ozs.
1902	535·00	445·88	·83
1903	722·00	612·98	·84
1004	1,484·00	925·07	·62
1905	522·00	301·67	·57
1906	821·00	363·50	·44
1907*	169·00	64·37	·38
Total ...	**4,253·00**	**2,713·47**	**·63**

* To 30th June.

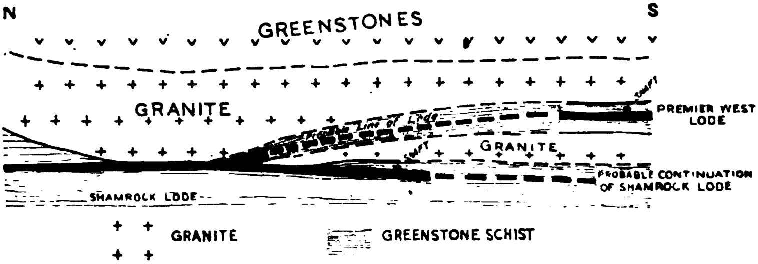
Shamrock, Premier West, and Hopeful, G.M.Ls. 586s, 602s, 767s, 783s.

This line of lode on these properties runs north-west and south-east, and dips steeply north-east, being parallel to the Premier line and lying about half way between it and the granite. It is not such a well-defined line as the Premier, but has been proved for a length of nearly half a mile, and probably extends a good deal farther both ways. The ore bodies occur in a narrow belt of greenstone schist, and are irregular both in size and occurrence, and also in their gold contents. There are no continuous quartz masses as there are in the Premier, and the ore bodies consist of a more or less crushed hornblende (actinolite) rock with which are occasionally associated small makes of quartz. The schist itself carries very little gold and is not payable.

On the Shamrock a main shaft has been sunk to a depth of 250 feet, but very little work has been done at this level, and the values are said to have been not too good. Most of the work has been done at the 80 feet level, and these were the only workings which could be examined. The present working shafts are down to this level, along which the lode has been opened up for a length of about 400 feet. Most of the stone above this level has been taken out.

The ore body varies in size from almost nothing up to seven feet, and is said to have averaged about 2½ feet; one make seven feet in thickness consisted of solid quartz and carried very good values, but as a rule the bulk of it consists of a more or less crushed actinolite rock irregular in its occurrence and also in its gold contents. In one place in the lode there is a seam of granitic schist about 12 inches in width running with the lode and carrying fairly good values. This is evidently an offshoot from a larger granite dyke a little farther east, which has evidently been subjected to the same shearing action, etc., as the enclosing schists. This main granite dyke at one place for a short distance forms the hanging wall of the lode, but soon gets away from it again. It has been cut through in the south shaft, and is here about 30 feet in thickness. Near the middle working shaft where this granite is in contact with the lode there can be seen in the bottom of the drive a small seam of quartz and schist going off into the granite wall. It is quite possible that this opens out and is a second lode going off between the two granite dykes as shown, and is the lode struck in the Premier West. The main Shamrock lode is on the western side of the granite all the way, and appears to be bearing away a little to the west the Premier West workings.

FIG. II.



Plan showing mode of occurrence of the Shamrock lode.

The water supply in the Shamrock main shaft is salt and is very limited. There is a five-head battery on the property and water for crushing purposes is obtained from a well on the flat about a mile to the south where an adequate supply is obtained. Water for boiler purposes is obtained from the Government dam.

On the Premier West, which adjoins the Shamrock on the south, a shaft has been sunk on what is supposed to be a continuation of the main Shamrock lode, and a crosscut has been put in across the line of it. This shows the ore body to consist of only about six inches of quartz in a narrow belt of greenstone schist enclosed on both sides by granite. The crosscut is said to have been driven 30 feet into the granite on the west side of the schists and then stopped. It appears quite likely that had it been continued a little farther west it would have passed through the granite, and probably have cut the real continuation of the Shamrock lode on the west side of it. It is more than probable that the lode worked is the small one mentioned previously as running off into the granite from the Shamrock line near the middle shaft. As far as is known there is no granite to the west of the Shamrock lode, and nothing can be learnt of the relation of the ore bodies by an examination of the surface, as everything is hidden beneath an extensive covering of recent deposits.

From this lease 118·50 tons were crushed, which yielded 104·38 ozs. of gold, or an average of ·88 ozs. per ton.

The Hopeful lease (G.M.L. 783s) adjoins the Shamrock on the north, and the workings are on a continuation of the same ore body. The deepest workings are at a depth of 80 feet, at which level the lode has been driven on for a length of 120 feet. It is exactly similar in character to that in the Shamrock, and is very irregular in size, and especially so in its gold values. A few seams of talc run through the lode, and these are said to occasionally carry very good values. The belt of greenstone schist in which the ore bodies occur appears here to have a width of about 30 feet. A small granitic dyke is said to form the hanging (eastern) wall of this schist belt, and behind this and to the westward is massive to slightly-foliated greenstone.

At the time of my visit some 120 tons of ore had been crushed for a yield of, roughly, 150 ozs. of gold. In taking out this ore the lode was worked over a width of from two to two and a half feet. There are no official returns shown from this lease.

Table showing the Yield from the Shamrock Leases.

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
	Tons.	Ozs.	Ozs.
1900	60·00	70·21	1·17
1901	274·00	236·93	·86
1902	368·00	352·28	·95
1903	196·00	410·38	2·09
1904	324·00	321·22	·99
1905	389·80	394·52	1·01
1906	485·50	735·62	1·51
1907*	390·00	350·09	·89
Total ...	**2,487·30**	**2,871·25**	**1·15**

* To 30th June.

London, G.M.L. 740s.

A well-defined line of reef runs through this block and the adjoining one to the south, and has been proved on the surface for a total distance of about 30 chains. It runs about north-north-west, and dips at a fairly flat angle to the west. It is some 10 chains to the west of a long tongue of intrusive granite (the southerly continuation of the Kintore body), and this probably accounts for the westerly dip as the prevailing dip throughout the district is to the east.

The reef is of solid quartz from three to five feet in average thickness, and is said to be worth seven or eight dwts. right through, but there are patches in it worth a good deal more. A fair amount of work has been done, mostly by the previous owners, and the reef opened up by levels at 100 and 160 feet, in addition to which the main shaft is said to have been sunk to a depth of 300 feet; water level is 160 feet, and the supply is, as usual, salt. At the present time very little work is being done on the property, the present owners working near the surface on a seam of quartz six to twelve inches in thickness, which runs along the hanging wall side of the main body, and is said to carry much better values than the rest of the reef.

Table showing the Yield from the London Lease.

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
	Tons.	Ozs.	Ozs.
1897	406·00	341·57	·84
1898	313·00	166·94	·53
1899	404·35	370·77	·91
1900	1,185·00	687·66	·58
1901	211·25	58·90	·27
1902	9·00	1·99	·22
1903	126·00	240·40	1·90
1904	137·00	68·10	·49
1905	626·75	272·44	·43
1906	43·00	169·45	3·94
1907*	26·00	173·12	6·66
Total ...	**958·75**	**923·51**	**·96**

* To 30th June.

Pantomime, G.M.L. 578s (189s).

The main workings on this property are situated on a well-defined line of reef running about north-west and south-east through almost the full length of the lease. A number of shafts have been sunk on it, and it has been opened up for a considerable length by levels at 60 and 80 feet. A main shaft has also been sunk to cut the reef at 160 feet. All these workings are now abandoned, and a little prospecting work is being done near the surface on a small leader near the eastern boundary of the lease. This leader runs about north-west and south-east, and is cut by several small cross veins. The leaders themselves are not of much value, but rich pockets are usually found at the points of intersection, one of these pockets taken from a depth of only about twelve feet is said to have yielded about two hundred ounces of gold.

The main line on which all the original work has been done is said to have been pretty irregular, ranging in thickness from a couple of feet to as much as twenty feet. It was not all solid quartz, but consisted of schist with rubbly seams and occasionally solid bodies of quartz through it. The values too are said to have been very erratic and mostly pretty low, but good values are said to have been struck in the bottom of the main shaft, but no work has been done there. The country is soft (greenstone), and so far no water has been met with.

The total gold production from this lease to the end of 1906 was 262 tons crushed for 216·96 ozs. of gold, or an average of ·82 ozs. per ton.

Table showing the Yield from Leases at Kunanalling, other than those already mentioned, up to 30th June, 1907.

Name and Number of Lease.	Ore crushed.	Gold therefrom.	Rate per ton.
	Tons.	Ozs.	Ozs.
Albert Mines Syndicate, Ltd., G.M.L. 15s	69·00	51·49	·62
Avondale, G M.L. 502s	83·00	36·66	·44
Bermondsey, G.M.L. 589s ...	45·00	22·96	·51
Big Blow, G.M.L. 439s	313·75	213·65	·68
Brevier, G.M.L. 35s	104·50	46·57	·44
Broncho, G.M.L. 458s (248s) ...	469·00	383·29	·81
Broncho North, G.M.L. 498s ...	20·00	13 35	·66
Broncho South, G.M.L. 497s ...	154·00	159·92	1·03
Bungarrow, G.M.L. 712s	32·00	17·83	·55
Castle View East, G.M.L. 404s ...	152·50	65 61	·43
Gharles Dickens, G.M.L. 190s ...	20·00	4·87	·24
Ellinor, G.M.L. 660s	11·00	10·74	·97
Forlorn Hope, G.M.L. 609s ...	52·00	20·99	·40
Fremantle Consols G.M. Co., N.L. G.M.Ls. 14s, 53s	134·00	348·21	2·59
Fremantle Extended, G.M.L. 568s	80·00	9·24	·11
General Buller, G.M.L. 626s ...	55·00	40·20	·73
Gladstone (Lady Evelyn G.M., Ltd.), G.M.L. 537s	67·00	20·06	·29
Gladstone Extended, G.M.L. 12s...	80·00	21·66	·27
Gold Explorers, Ltd., G.M.L 16s	95·50	47·60	·50
Golden Fremantle Co., N.L., G.M.Ls. 568s, 652s (526s) ...	462·00	146·59	·31
Great Northern Star, G.M.L. 751s	65·00	17·58	·27
Lochiel, G.M.L. 673s (1,285w) ...	51 00	168·79	3·31
Mary Anne, G.M.L. 691s... ...	33·00	14·84	·45
Mildura, G.M.L. 714s	...	*28 55	...
Multum in Parvo, G.M.L. 248s ...	55·00	60·07	1·09
New Fremantle, G.M.L. 731s (568s)	252·50	145·52	·58

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* Dollied and specimens.

Table showing the Yield from Leases at Kunanalling, other than those already mentioned, up to 30th June, 1907—continued.

Name and Number of Lease.	Ore crushed.	Gold therefrom.	Rate per ton.
	Tons.	Ozs.	Ozs.
Nil Desperandum, G.M.L. 625s ...	189·00	126·76	·67
Nil Desperandum, G.M.L. 726s ...	134·00	432·08	3·22
Palmer, G.M.L. 427s	93·50	60·80	·65
Pearce's Find, G.M.L. 243s (2,838)	33·00	64·34	1·95
Pearce's Kunanalling Co., N.L., G.M.L. 524s	56·00	·28	...
Royal Sovereign G.M. Co., Ltd., G.M.L. 45s	92·00	206·15	2·24
Sydney Mint Leases, G.M.Ls. 603s (472s), 490s	474·75	1,736·00	3·65
Travenor, G.M.L. 281s	30·00	4·56	·15
Troedyrhiw, G.M.L. 697s (676s)...	19·00	185·99	9·78
Try Again, G.M.L. 528s (439s) ...	137 00	219·32	1·60
Vincent, G.M.L. 563s	20·00	9·15	·45
Waratah, G.M.L. 616s	96·00	104·26	1·08
White Funnel Main Reef, G.M L. 669s	29·00	14·76	·51
Sundry Claims	1,750·35	923·45	·52

Sundry Gold Returns from the Kunanalling District generally.
(To 30th June, 1907).

Treatment Works.	Ore crushed.	Gold therefrom.
	Tons.	Ozs.
Sundry parcels treated at Bow's Battery	195·00	55·34
Do. Hepburn's Cyanide Works	...	184·39
Do. Orotava Works, Kalgoorlie	...	27·22
Do. Stanley Battery	5·50	42·26
Do. State Battery, Siberia ...	35·50	8·02
Do. Pride of Jourdie North Battery	18·00	15·01
Do. Various Works	1,230·66	713·52
Reported by banks and gold dealers	...	20·25

KINTORE.

This centre is situated about six miles from Kunanalling, lying a little west of north of the latter place. It was once a fairly busy district, but has to all intents and purposes been abandoned for some time past.

A reference to the map herewith will show that the country is essentially greenstone, but that occupying the central portion where most of the original workings were situated is a large mass of intrusive granite. This has a maximum width of about a mile and a half, and as shown on the map runs to a point a couple of miles to the south towards the London, G.M.L. 740s. Its exact limits in this direction are very difficult to accurately define owing to the extensive recent deposits which cover most of the country in this direction. The northern portion of this granite area occupies a slight depression surrounded on the north and west by greenstone ridges, and having a general fall to the eastward, in which direction the granite soon disappears beneath extensive recent deposits, which continue easterly for a considerable distance. The approximate limits of the granite in this direction are marked by shafts which have been put down in different places. On the north the junction of this granite with the greenstones is well marked, and it can be seen dipping under the latter at a comparatively flat angle. Along and close to the junction the greenstones are highly crushed and foliated, the foliations running parallel to and dipping away from the junction with the granite which is massive and shows no signs of foliation. A mile or so to the west of the old townsite on Water Right 37/98 is a shaft which has been started in greenstone, and has apparently bottomed on massive granite similar to that forming the main mass. This shaft is evidently close to the junction which, however, is not visible here, owing to the covering of recent deposits.

A little distance from the granite the greenstones are massive and consist of a tough fine-grained hornblende rock identical with that occurring at Kunanalling. A few granitic dykes run through these greenstones close to the main granite mass, from which they are apparently merely offshoots. A couple of these have been cut in the underground workings on G.M.L. 137, and in this case they more closely resemble a quartz porphyry than a granite. As a rule these dykes are small and cannot be traced on the surface owing to the detrital deposits hiding all detail.

Over the whole of the depression area the granite is very much weathered and kaolinised, and is extremely soft down to a depth of about 100 feet, thus making mining easy down to this depth, as the country stands well.

Quartz reefs are found both in the greenstones and in the granite, and also along the junction of the two classes of rocks. They are as a rule small and irregular—those in the granite being particularly so—and so far have not proved of payable value. A fair number of them have been worked at one time or another, but apparently without satisfactory results, and they are, with one exception, all now abandoned.

The reefs in the granite are found close to the junction, and have no regular strike or dip. They are mostly only leaders a few inches in thickness, and have no length of course and probably no great depth.

The "Cement" deposits which first brought this district into prominence and out again are situated in the central granite depression. They will be described later.

At the present time the only work being done in the district is on the Sugarloaf, G.M.L. 734, where a small party is working a quartz leader. This lease was originally the property of the Cement Company, and a good deal of work was done on it, mostly on separate irregular quartz veins. These were in granite, on or close to its junction with the greenstones, and, being small and of very low grade, were soon abandoned by the original owners. The present party is working at a depth of about 50 feet on a small quartz leader running east and west and averaging only a few inches in thickness. The leader is in soft kaolinised granite, and the country just here is full of them, but as a rule they are of no value.

The Cement Leases.—These leases are now idle, and no work has been done on them for some time. The company originally held a large area of ground, and a lot of irregular and disconnected work has been done, most of which was on G.M.Ls. 734s, 735s, and 100s.

In reporting on these Cement Deposits in 1898, Mr. T. A. Rickard* describes them as follows :—

> "Under a thin covering of sand and dust there occurs a bed of "kaolin ranging from a couple of inches to a foot in thickness, and this "overlies from fifteen inches to two feet of 'sand-rock,' which in turn

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* "The Alluvial Deposits of Western Australia," by T. A. Rickard, State Geologist, Denver, Colorado. Trans. A.I.M.E., 1898.

" gives place to the gold-bearing cement, which has an average thickness
" of two and a half feet. The last lies directly upon an irregular surface
" of decomposed granite. The several layers composing the deposit are
" separated by seams of pipeclay, which like the kaolin are simply the
" product of the decomposition of the constituents of the granite,
" particularly the felspar. The 'sand-rock' may be described as a
" course incompletely consolidated sandstone or grit, consisting mainly of
" iron-stained particles of quartz loosely cemented. The cement has a
" bluish grey tinge owing to the play of light on the quartz fragments.
" This, too, is not quite compacted since fractures through the material
" do not break across the pebbles which are harder than the clay binding
" them together. The binding material, the overlying layer of kaolin,
" and the sand-rock capping the gold-bearing stratum of cement all
" exhibit very clearly their derivation from a decomposed granite similar
" to that which encloses the reefs and forms the bed-rock of the alluvium
" itself."

The deposit has been worked along two small converging gullies, in the beds of which the best values were obtained. Most of the work has been done by open cutting, but a good deal of driving and tunnelling has also been carried on.

The " cement " consists of an intimate mixture of kaolin and small quartz particles occasionally showing slight signs of stratification, and is undoubtedly partly of alluvial origin and partly the result of decomposition *in situ* of the underlying granite. Owing to their great similarity it is impossible to separate the two, though the alluvial portion occupies probably the upper couple of feet. Mixed with this upper two feet is a good deal of rubbly quartz, some of which has evidently been derived from the weathering out of small seams in the granite, and some from a quartz reef outcropping a few chains to the north on rising ground. This is a fair-sized but very irregular and lenticular reef occurring along the junction of the granite with the greenstones. It has been proved to carry gold in places, and a little work has been done on it, but it does not appear to have been rich enough to pay. Overlying the whole is an accumulation of about four feet of fine silt.

The "cement" has been worked for a depth of from three to five feet over an average width of about a chain, the workings being confined principally to the beds of the two gullies, along which the best values are said to have been found. There is no defined limit to the depth of the cement, mining operations having simply ceased where values were too low to pay. Although some of the gold in the "cement" is probably of secondary origin the bulk of it is merely alluvial—derived principally from the weathering out of small auriferous quartz seams—and has simply been concentrated in the wash and soft-rotted granite along the beds of the gullies.

The payable portion of the deposit has apparently been long since worked out, and though there is probably a large quantity of low grade material available its gold contents are not such as to be likely to ever render it a payable proposition.

Table showing the Yield from the "Cement" Leases at Kintore, up to 30th June, 1907.

Year.	Name and Number of Lease.	Ore crushed.	Gold therefrom	Rate per ton.	Total.		Average rate per ton.
					Ore crushed.	Gold therefrom	
		Tons.	Ozs.	Ozs.	Tons.	Ozs.	Ozs.
Previous to 1897 ..	§Ormuz G.M.L. 77s ..	35·50	7·65	·21			
1898 ..	Do.	2,682·25	2,146·95	·80			
1899 ..	Do.	1,802·00	2,232·36	1·23	4,519·75	4,386·96	·97
1897 ..	§Great Dyke and Orizaba Cement Claims Ltd., G.M.Ls. 93s, 99s, 135s/9s	3,532·00	1,012·82	·28			
1898 ..	Do.	5·00	39 15	7·83	3,537·00	1,051·97	·29
1897 ..	Sugarloaf 25-mile Cement Leases, Ltd., G.M.Ls. 129s, 359s, 409s, 161s, 132s, 114s, 489s (129s), 734s (132s), 677s (161s), 482s (359s)	146·00	688 37	4·70			
1898 ..	Do.	153·50	345·94	2·25			
1900 ..	Do.	88·00	48·12	·55			
1901 ..	Do.	65·00	78·22	1·20	452·50	1,160·65	2·56
1902 ..	Sugarloaf (Great Cement Proprietary, Ltd.), G M.L. 409s	172·00	185·48	1·07			
1903 ..	Do.	169·00	92·50	·56	341·00	277·98	·82
1899 ..	Welcome Sailor, G.M.L. 489s	..	..	..	70·50	95·02	1·35
1897 ..	§W.A. Proprietary Cement Leases, G.M. Ls. 105s, 100s	4,102·00	6,724·04	1·64			
1898 ..	Do.	478·75	296·71	·62			
1899 ..	Do.	.	‡128·45	..	4,575·75	7,049·20	1·54
1902 ..	Kintore North, G.M.L. 482s	..	..	..	56·00	88·64	1·59
1899 ..	Great Cement Proprietary, Ltd., G.M.Ls. 77s, 93s, 99s, 100s, 105s, (135s, 137/9s)	5,742·00	1,188·98	·21			
1900 .	Do.	3,184·00	602·73	·18			
1901 ..	Do.	5,494·00	912·60	·16			
1902 ..	Do.	731·00	529·46	·72			
1903 ..	Do.	15 00	1,409·18	93·94			
1904 ..	Do.	840·00	501·03	·59			
1905 ..	Do.	595·00	234·01	·39			
1906 ..	Great Cement Proprietary, Ltd., G.M.Ls. 734/5s	31·75	*615·77	..			
1907† ..	Do.	63·50	118·28	1·86	16,696·25	6 107·04	·36

§ Transferred to Great Cement Proprietary, Ltd., in 1897. * Includes 539·65 ozs. by cyanide.
† To 30th June. ‡ Dollied and specimens.

Hands Across the Sea, G.M.Ls. 721s, etc.

A good deal of shallow work has been done on these leases and also a little at the 180 feet level, but the property is now practically abandoned, and no work to speak of has been done on it for some time. The workings were inaccessible, and could not be inspected There are said to have been several parallel ore bodies consisting of a series of irregular lenses of quartz of no great length or depth. The main reef, on which most of the work has been done, is said to have reached as much as thirteen to fifteen feet in thickness at one place, but this only for a very short distance. The shoot of gold is said to have been very short.

The ore bodies are in a belt of schistose greenstone close to the main body of granite.

There is a good supply of salt water in the main shaft.

Table showing the Yield of the Hands Across the Sea Reef.

Year.	Name and Number of Lease.	Ore crushed.	Gold therefrom	Rate per ton.	Total.		Average rate per ton.
					Ore crushed.	Gold therefrom	
		Tons.	Ozs.	Ozs.	Tons.	Ozs.	Ozs.
Previous to 1897 ..	Hands Across the Sea G.M. Co., Ltd., G. M.Ls. 61s, 62s	45·00	30·61	·68	2,963·75	2,063·95	·69
1897 ..	Do.	290·00	178·04	·61			
1898 ..	Do.	1,267·00	878·16	·69			
1899 ..	Do.	871·00	711·35	·81			
1900 ..	Do.	80·00	58·79	·73			
1901 ..	Do. . ..	410·25	207·00	·50			
1901 ..	Hands Across the Sea Leases, G.M.Ls. 61s, 62s	185·00	195·62	1·05	689·00	577·60	·82
1902 ..	Do.	491·00	370·82	·75			
1903 ..	Do.	13·00	11·16	·85			
1905 ..	Hands Across the Sea, G.M.L. 721s (61s)	12·00	6·70	·56	111·50	85·79	·77
1906 .	Do.	80·50	64·02	·80			
1907* ..	Do.	19·00	15·07	·79			
	Total ..	..	..	..	3,763·75	2,727·34	·72

* To 30th June.

Table showing the Yield from Leases at Kintore, other than those already mentioned, up to 30th June, 1907.

Name and Number of Lease.	Ore crushed.	Gold therefrom.	Rate per ton.
	Tons.	Ozs.	Ozs.
British Lion, G.M.L. 444s ...	59·50	83·63	1·41
Castle Hill, G.M.L. 123s	121·00	158·21	1·30
Castle Hill, G.M.L. 595s, (123s) ...	50·25	12·82	·25
Castle Hill Extended, G.M.L. 454s	21·00	34·32	1·63
Central Exploration Co. of W.A., Ltd., G.M.L. 23s	10·00	4·35	·43
Daisy Bell, G.M.L. 445s	185·50	154·80	·83
Doncaster G.Ms., Ltd., G.M Ls. 49s, 259s, 260s, 289s, etc. ...	1,990·30	1,358·27	·68
Glenmore, G.M.L. 424s	98·50	152·93	1·56
Golden Crest, G M.L. 49s... ...	10·00	4·50	·45
Goulbourn Extended, G.M.L. 256s	99·30	65·27	·65
Great Junction, G.M.L. 442s ...	344·80	342·04	·99
Hands Across the Sea United, G.M.L. 89s	40·80	36·10	·90
John Bull, G.M.L. 447s	119·50	139·79	1·17
John Bull East, G.M.L. 462s ...	70·00	105·33	1·50
Kiaora, G.M.L. 405s	101·50	365·16	3·61
King Bruce, G.M.L. 505s... ...	33·50	12·73	·38
Kinross, G.M.L. 269	24·00	21·94	·91
Lady Alice, G.M.L. 420s	28·00	20·52	·73
Lady Elizabeth, G.M.L. 414s ...	9·75	8·30	·84
Last Chance, G.M.L. 516s ...	56·00	131·03	2·34
Life Boat, G.M.L. 446s	33·00	11·76	·38
Rajah Brook, G.M.L. 658s, (612s)	25·00	21·20	·84
Sarmatia, G.M.L. 491s	66·50	625·12	9·40
Stockdales Consols, G.M.L. 671s...	...	*·49	...
Tom's Retreat, G.M.L. 576s ...	62·00	49·00	·79
Truth, G.M.L. 632s	68·00	29·67	·43
Zealandia, G.M.L. 575s	8·00	12·17	1·52
Sundry Claims	608·50	685·79	1·12

* Dollied and specimens.

CARBINE.

For the first two or three miles along the main road from Kintore the country towards Carbine consists of low greenstone ridges with small intervening salt bush flats, but from this on it consists of one extensive plain covered with a considerable thickness of recent deposits. This plain extends north and west beyond Carbine for some considerable distance.

There is a fairly heavy growth of white gum all over these plains, so that the district is well supplied with mining timber.

At Carbine itself are one or two low rises over which are small outcrops of greenstone schists. The foliation of these schists runs about north-west and south-east, and they apparently occupy the whole surrounding district, as no massive rocks whatever can be seen until a point a couple of miles south of Carbine is reached.

As far as the mine workings show these schists have undergone extensive weathering, and are soft and rotten down to a considerable depth.

The district is not well-watered, the supply being salt and, so far, very limited. In the Carbine mine the supply (from about 350 feet) is only sufficient to keep 10 head of stamps going about half time, and is said to be diminishing. If the district should go ahead and more water for battery purposes be required, it will in all probability have to be brought down from the neighbourhood of the Carnage lakes, some three or four miles to the north, where there is said to be a good supply.

As stated before there is an abundance of good timber throughout the district.

Carbine, G.M.L. 33s.

This is the principal mine of the district, and is the only one on which any work worth speaking about has been done. The present workings are at a depth of about 330 feet, this being the only level at which any work is at present being done. A little driving has been done at the 260 feet, but the workings were said to have fallen in and to have been inaccessible A good deal of irregular work has also been done near the surface, but these workings are now abandoned and were mostly inaccessible. A reference to the plan (Plate V.) will show the amount of work which has been done at the 330 feet level. Very little stoping has been done, the block shown having been worked to twenty to thirty feet.

The workings are in a wide belt of schist, which is apparently no different to the enclosing country, and strikes roughly north-west and south-east dipping at an angle of about 60 degrees to the north-east. Throughout the whole of the lower workings this schist is said to carry a little gold—variously estimated at from one to six dwts.—but the best values have been obtained at the south-west end of the workings where there is a fair amount of quartz associated with the schist. This quartz occurs in small veins running both with and across the schist, and also in occasional fair-sized bodies. The width of the zone throughout which it occurs appears to be about thirty feet, and its trend is with the run of the schist, *i.e.*, about north-west and south-east, dipping 60 degrees north-east. There are no defined walls visible anywhere in the workings, and the whole deposit is very irregular and ill-defined. Taken as a whole the gold contents of the lode are very low grade, but occasionally rich patches are found which considerably improve the average values. The gold in these patches is usually found in quartz, but occasionally in the schist, and never far away from the quartz. A good deal of pyrites occurs both in the quartz and throughout the schist. It does not appear, however, to carry any values.

Throughout the lower workings the schist is a good deal decomposed and is fairly soft. It stands well, however, and working is comparatively easy. Near the surface the whole country as far as the workings extend is full of small quartz veins and rubbly quartz, but there is nothing defined in the way of a lode.

The only outcrops visible on the surface are a big quartz blow a little south of west of the main shaft, and one or two other short irregular makes of quartz. These are merely short lenses running and dipping with the schist. The big blow is probably connected with the quartz bodies upon which the Carbine workings are now situated.

Table showing the Yield from the Carbine Lease.

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
	Tons.	Ozs.	Ozs.
1899	70·00	26·76	·38
1900	63·00	108·05	1·71
1902	175·00	82·19	·47
1903	1,215·00	541·00	·44
1904	1,258·00	583·56	·46
1905	902·00	*385·07	·42
1906	3,000·50	†2·219·62	·74
1907‡	1,577·00	751·91	·47
Total ...	**8,260·50**	**4,698·16**	**·56**

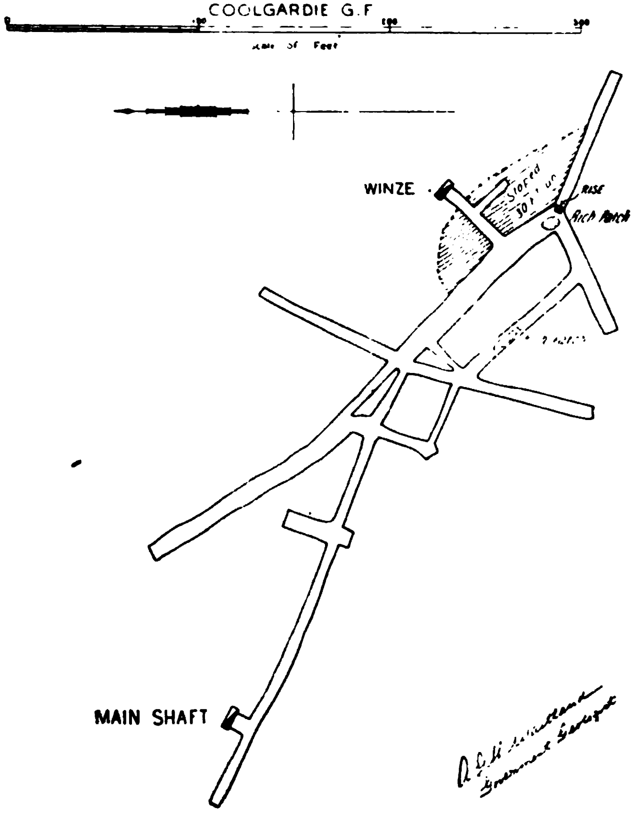
* Includes 79·81 ozs. dollied and specimens. † Includes 597·32 ozs. dollied and specimens. ‡ To 30th June.

Carbine South, G.M.L. 758s.

On this lease the owners have sunk to 400 feet, and are now crosscutting to try and pick up the continuation

BULLETIN Nº 31 *(PART I)* PLATE V

PLAN OF
325 FT LEVEL
CARBINE G.M.L. 33^S
COOLGARDIE G.F



A. Gibb Maitland
Government Geologist

TAKEN FROM MINE PLANS

del

of the Carbine lode. The whole formation so far passed through consists of a fairly soft greenstone schist with seams of calcite and occasionally small veins of quartz. No payable values have as yet been met with.

Spearmint, G.M.L. 776s.

On this block a small lenticular vein of quartz has been worked to a depth of 100 feet, but it has not been opened up for any great distance. The quartz varies in thickness from a mere thread up to as much as four feet, but the lenses are very short and irregular. The reef is in greenstone schist and runs parallel to the lines of foliation, *i.e.*, about north-west and south-east. No crosscutting of the country has been done or it would very probably have proved the existence of other parallel similar makes of stone.

Table showing the Yield from Leases at Carbine, other than those already mentioned, up to 30th June, 1907.

Name and Number of Lease.	Ore crushed.	Gold therefrom.	Rate per ton.
	Tons.	Ozs.	Ozs.
Carbine South, G.M.L. 758s ...	22·00	10·29	·46
Carney's Success, G.M.L. 540s ...	18·50	11·76	·63
Globe, G.M.L. 591s	95·00	326·70	3·43
Grafter, G.M.L. 667s	112·00	77·09	·68
Nordenfeldt G.M. Co., N.L., G.M.L. 73s	744·00	795·79	1·07
Nordenfeldt South, G.M.L. 334s...	398·50	589·78	1·48
Spearmint, G.M.L. 776s	64·00	98·74	1·54
Sundry Claims	39·00	21·87	·56

DUNN'S EIGHT MILE.

From Carbine towards the Eight Mile the country for the first two miles or so consists of salt bush plains and then of low greenstone ridges alternating with small flats, this class of country being then continuous into Kintore. The ridges are often covered with a thin capping of rubbly ironstone, but there is never any great extent of it.

At the Eight Mile a considerable amount of alluvial work (dry-blowing) has been done, and one or two small quartz leaders have been worked, but the place is now practically abandoned.

Sarmatia, G.M.L. 785s.

On this lease a small party is working a quartz leader about a couple of inches in thickness, from which a fair amount of gold is said to have been won. This leader has been worked to a depth of about 60 feet, but only for a short length. The stone is either rich dollying stone or else no good at all. The country is a foliated and slightly schistose greenstone, the foliations running north-west and south-east, and dipping at an angle of about 60 degrees to the north-east, and the leader strikes and dips with the country.

One or two small granitic dykes intersect the greenstones here, these being probably connected with the main granite body which is said to lie a couple of miles to the south.

Several small areas have been worked for alluvial about here, and a fair amount of gold has been won, but nothing very big was obtained. This gold has evidently been derived from the weathering down of small quartz leaders, of which there are numbers running through the schists, and many of these have doubtless carried good values.

Balgarrie and Balgarrie Extended, G.M.Ls. 759s, 760s.

These leases are situated about 13 miles a little west of north of Kunanalling on a continuation of the same belt of greenstones, most of the intervening country consisting of salt bush flats covered to a considerable depth with recent deposits. A few miles south from the Balgarrie are several leases on which a fair amount of work has been done on a couple of small quartz reefs. The workings show the country to be fairly hard, and to consist of massive to slightly-foliated greenstone. Little or no work is being done on these leases at the present time, and they are practically abandoned.

In the Balgarrie leases the "lode" consists of a large felsite dyke, which runs on a bearing slightly west of north and east of south for a distance of probably well over a mile, and underlies very slightly to the west (2 feet in 100 feet). This main dyke has a width varying from 50 to 120 feet, and can be followed on the surface in an almost perfectly straight line for over half a mile. Its outcrop is hidden at either end beneath recent deposits, so its actual length is probably a good deal more than this. In addition to this dyke two others have been exposed on the lease, one about 50 feet wide running parallel to it and about a chain to the west, and the other, a smaller one, running slightly south-westerly into the main one a few chains north of the principal workings.

The country in which these dykes occur is a massive to slightly-foliated greenstone much crushed and altered along the immediate contact with them. A little short-fibre asbestos is found here and there in the schistose greenstone bounding the main dyke, and gold is said to have been obtained in this in fair-sized pieces. A little gold is always obtainable in the schist, but as a rule not much more than a trace.

Gold is said to have been obtained from end to end of the main dyke, but mostly only in very small quantities, as shown by the assay results given later. The best values were got about the middle of the lease, where the main workings are situated, and even here they are not too good. The gold does not appear to be in the dyke rock itself but rather to be deposited along cleavage cracks, of which there are a great number running in all directions. The rock appears to have undergone considerable alteration just along these cracks, and a film of quartz is generally found covering it along the larger cracks, and it is this altered portion and the quartz which carries most of the gold. In the soft decomposed portions near the surface the quartz is sometimes found in veins half an inch or more in thickness. A little gold appears to have been deposited throughout a good part of the soft weathered portion of the dyke close to the surface, but the hard unaltered rock at a depth is very poor in values.

The following are the results of three assays made in the Departmental Laboratory of samples taken by myself. The samples were obtained by chipping typical fragments from a number of different places, and may be taken as fairly representative :—

No. 1 —Gold, 20 grains per ton. Silver, trace.

No. 2.—Gold, 6 dwts 22 grains per ton. Silver, trace.

No. 3.—Gold, 13 grains per ton. Silver, trace.

No. 1 was broken from surface stone at the north end of the outcrop.

No. 2 was from the dump at the main open cut.

No. 3 was from stone taken from the crosscut from the bottom of the 100 feet shaft.

The only work done on the leases consists of an irregular opencut 40 to 50 feet deep near the middle of the lease from which all the stone crushed has been taken. The stone in this opencut is all a good deal weathered and contains a fair number of small quartz seams. The dyke has here a width of about 120 feet, but most of the stone has been taken out near the eastern wall. This stone is said to have crushed about 6 dwts. per ton.

The only other work done consists of a vertical shaft sunk to a depth of 100 feet, at which level a crosscut has been driven some distance into the lode. This, as shown by the assays, exposed very poor stone.

Not much work is being done on the leases at the present time.

A little alluvial gold was obtained along the outcrop of the dyke where the present workings are situated, but the gold was mostly fine and there was not much of it. It had probably been shed from the small quartz veins in the dyke.

No water has been met with so far, as the leases are on fairly high ground

There is an abundance of good timber in the neighbourhood.

JOURDIE HILLS.

Between Kunanalling and Jourdie Hills the country is all granite and mostly flat and covered with a considerable thickness of loose sandy soil. The range of hills from which the locality takes its name rises from these flats to a height of from 200 to 300 feet, and has a maximum width of some two miles and a length of about four miles. Its general trend is about north and south, and the rock is a fine-grained massive and slightly foliated greenstone.

The granite apparently extends almost to the foot of the hills, but its actual junction with the greenstones is hidden beneath the recent deposits These latter also cover the whole of the country to the south and west of the hills South and south-east towards Coolgardie the underlying rock appears to be granite, but to the westward for some distance it is greenstone. Northward this greenstone belt extends on some miles past Dunnsville. The country is mostly flat with only occasional low ridges, the intervening portions being occupied by extensive salt bush flats.

The ore bodies of the Jourdie Hills district are quartz reefs mostly of the normal fissure type with every sign of permanency, and are as a rule of fair size and considerable length, one or two of them having been proved for a length of about half a mile. There are, however, in addition to these main lines numbers of small quartz leaders an inch or so in thickness, many of which carry good gold values, and from the breaking down of these most of the alluvial gold has evidently been derived. Some of these leaders are fairly persistent and run for considerable distances, whilst others are of very short length. All the main lines of reef exhibit a marked parallelism, striking as a rule five to ten degrees west of north and dipping to the west at an angle of about fifty degrees. Both the larger reefs and the leaders exhibit at times a marked lenticular habit, but this can hardly be said to be the general characteristic. The quartz in the larger reefs is usually white and glassy, being very hard and solid, and as a rule of low grade, though some fairly good crushings have been taken out of one or two of them.

A considerable quantity of alluvial gold has been obtained from the gullies running down from the hills, at a depth of from two to six feet, and mostly from those on the western side. This gold has undoubtedly been derived from the breaking down of small quartz leaders running across the gullies, and as a rule it is small, but one or two good-sized pieces have been found.

Near the townsite on the flat at the south-west foot of the hills, a water shaft has been sunk to a depth of about 105 feet. At 100 feet a couple of feet of "wash" is said to have been passed through, which carried no gold, but is thought by the local residents to be the channel of a "deep lead" opening out to the south. I was unable to descend this shaft owing to its being unsafe and so examine this "wash," but the possibility of picking up a "deep lead" on the flat to the south seems to me to be very remote.

The water supply, in such of the mines as are down to water, is salt. A good supply is obtained from a well on the flat half a mile or so south of the townsite, the water being only brackish until heavily drawn upon when it becomes salt. For a domestic supply the residents depend on rain water conserved in a large covered dam recently made by the Government.

The district is well supplied with timber (gum) of good quality both for mining purposes and for fuel.

THE MINES.

The majority of the mines working are only in the prospecting stage, but one or two of them appear likely to develop into important properties.

The following are brief descriptions of those working at the time of my visit (August, 1907):—

Pride of the Jourdies, G.M.L. 369s.

A good deal of work has been done on this property by the company which owned it originally, but these workings have been abandoned for some time, and have mostly fallen in and are inaccessible. Part of the work was on the southerly continuation of the leader worked in the Pride of the Jourdies North, but most of it was on a small parallel leader a couple of chains farther east. This only averaged a couple of inches in thickness, and appears to have been very irregular in its strike, the general line of which is a little west of north. The dip is about 45 degrees to the west. This leader is said to have been completely worked out, and to have had some very rich patches in it.

At the present time a small party of tributors are working a small leader lying a few feet from the original one and running roughly parallel to it. This leader is only a couple of inches in thickness, and is pretty well worked out Although fairly rich in places it was not nearly so good as the original one.

Most of the work on the leases has been above the 200 feet level.

The country consists of foliated greenstone very soft and rotten and requires heavy timbering.

Table showing the Yield from the Pride of the Jourdies Reef.

Year.	Name and Number of Lease.	Ore crushed.	Gold therefrom	Rate per ton.	Total.		Average rate per ton.
					Ore crushed.	Gold therefrom	
		Tons.	Ozs.	Ozs.	Tons.	Ozs.	Ozs.
1897 ..	Pride of the Jourdies, G.M.L. 369s (3,403)	44·00	91·22	2·07			
1899 ..	Do.	166·00	142·15	·85			
1900 ..	Do.	90·08	116·40	1·29			
1901 ..	Do.	110·66	115·70	1·06			
					410·74	465·47	1·13
1902 ..	Jourdie Hills G.M. Co., Ltd., G.M.Ls. 369s, 661s	286·00	214·65	·75			
1903 ..	Do.	4,252·00	2,779·95	·65			
1904 ..	Do.	3,566·00	2,665·97	·75			
1905 ..	Do.	1,054·00	793·01	·75			
1906 ..	Do.	285·00	966·91	3·39			
1907*..	Do.	156·00	263·81	1·69			
					9,599·00	7,684·30	·80
	Total	..	..	..	10,009·74	8,149·77	·81

* To 30th June.

Pride of the Jourdies North, G.M.L. 514s.

The workings on this property are on a small quartz leader running a little west of north and dipping at an angle of about 45 degrees to the west. In thickness this leader ranges from one inch to a foot, averaging about eight inches, but in one spot it widened out to as much as five feet. This, however, was only a short bulge, and only extended for a few feet each way. Its general trend, as above stated, is about north north-west, but it twists about all over the place. There are no defined walls to it, and the country is a good deal broken. A second leader runs parallel to the main one in the upper workings lying a few feet away on the hanging wall side. This is very small and not much good, and it comes into the main one just above the 100 feet level.

The main leader has been worked to a vertical depth of 180 feet (water level) for a length of about 240 feet. Little or no stoping has been done below the 100 feet level, but practically all the stone above this has been taken out. The bulk of the stone is fairly low grade, but rich patches are met with which bring the general average up fairly high.

As in the adjoining leases the country is very soft and rotten, and requires extensive timbering.

The water supply is salt.

Table showing the Yield from the Pride of the Jourdies North Lease.

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
	Tons.	Ozs.	Ozs.
1899	26·00	25·94	·99
1900	82·50	64·74	·78
1903	227·00	142·18	·62
1004	181·00	104·49	·57
1905	288·00	162·45	·56
1906	287·00	168·29	·58
1907*	87.00	29·86	·34
Total ...	**1,178·50**	**697·95**	**·59**

* To 30th June.

Jourdie Enterprise, G.M.L. 773s,

This property is situated about two miles north-west of the Jourdie Hills township.

There is a large well-defined line of reef running through this and the adjoining leases, but so far no very great amount of work has been done on it, the deepest workings being only down to a depth of 100 feet. It has been proved on the surface for a length of about 30 chains, and probably extends a good deal farther than this. Its average thickness is from one to four feet. The strike is about 10 degrees west of north, and its dip is to the west at an angle of from 40 to 50 degrees.

On the Jourdie Enterprise this main reef has been proved to carry more or less gold right along, but very little work has been done on it, all the present work being on a branch reef lying 15 to 20 feet to the east. This reef branches off from the main one about the middle of the lease, and runs for a distance of 300 fe before joining it again, being some 20 feet distant from it at the farthest point. The main shaft on this reef has been sunk to a depth of 100 feet, at which level a drive has been put in along the reef for 120 feet. Little or no stoping has been done. The reef consists of clean white solid quartz, and is very regular in size, having an average thickness of about three feet. Throughout the workings the walls are clean and well defined, and the reef has every indication of permanency. The values are said to be fairly regular throughout, and to be improving slightly at a depth.

The country is a fine-grained massive greenstone, and so far is very soft and rotten. No water has been met with up to the present.

At the south end of this lease the reef crosses a good-sized gully in which a considerable amount of alluvial work has been done. It is here much more broken and irregular, and it seems probable that the alluvial gold has been shed from small leaders rather than from the main reef, as so far no specimen stone has been obtained from the latter.

To 30th June, 1907, 121 tons of ore have been raised from this lease, which produced 63·42 ounces of gold, or ·52 ounces per ton.

For a distance of nearly two miles makes of stone, often of fair length, occur in an exact line with the Enterprise reef, and are evidently connected with the same line of fissuring, though no connection can be seen on the surface. One or two of these reefs have been worked but, so far, results have not proved altogether satisfactory.

Jourdie Enterprise South, G.M.L 786s.

This lease, which adjoins the preceding one on the south, has been worked on the same line of reef, but in a somewhat irregular and disconnected manner. Two shafts have been sunk each to a depth of 50 to 60 feet, but very little driving has been done from either of them. A little opencutting also has been done. In the north shaft the reef at the surface is from six to eight feet in thickness, but has pinched out to practically nothing at the bottom. It will, however, most probably open out again if sunk on further. In the south shaft it is also pretty irregular, but not so much so as in the north shaft. The values are said to be fairly low and to be very erratic. One or two small pockets of good stone have, however, been already met with.

The reef on the surface is not so well defined or regular as on the preceding lease, and does not appear to continue much ther to the south.

To 30th June, 1907, 91 tons of ore raised yielded 39·42 ounces of gold, or at the rate of ·43 ounces per ton.

Graham and Party (Derry's Own, G.M L. 789s) **and Sexton and Party.**

These parties are working on a well defined line of reef running parallel to the Enterprise line and lying 20 chains or so to the east of it. Graham and Party are working about the centre of the line of outcrop and Sexton at the north end. There is a strong well-marked line of reef which can be followed on the surface for from 20 to 30 chains. Its strike is about 10 degrees west of north, and it dips to the west at an angle of about 45 degrees.

On Graham's lease a shaft is down about 60 feet, and from it a little driving has been done. Where exposed in these workings the reef is from three to five feet in thickness and fairly regular, consisting of hard solid clean quartz. The stone as a whole is of low grade, but the values are said to be improving in the bottom of the shaft.

At the north end, Sexton and party have a shaft down about 60 feet, at which depth they have done about 50 feet of driving. Here the reef is more irregular, varying in thickness from 2 to 7 feet. At the present time a six to 12 inch seam of stone along the footwall of the reef is being worked. This is said to carry fairly good values, while the remainder of the stone is at present a little too low grade to pay to work.

There is a third good-sized well-defined line of reef running parallel to the Enterprise line, and lying half a mile or so southwest of it. A little work has been done on this, but it was apparently of too low grade, and it is now abandoned.

Wealth of Nations, G.M.L. 17s.

This once famous property is situated at Dunnsville about five miles to the north of Jourdie Hills townsite. The country is all fine-grained massive greenstone and is a continuation of the Jourdie Hills belt. There are a few low hills where the leases are and these are mostly capped with a thin covering of ironstone gravel (laterite). A belt of granitic rocks is said to lie a couple of miles to the east of Dunnsville and to run between that centre and the Eight Mile; this is the continuation of the Kunanalling belt which has here evidently narrowed in considerably. The locality was at the time of my visit practically deserted; one small party were working on the south end of the

Wealth of Nations reef, and another on a small quartz reef half a mile or so to the west; in addition there were one or two dry-blowers about but they were doing very little. Little or nothing was being done on the Wealth of Nations beyond a little "rooting" in the upper levels by a small party of tributors.

The reef on this property runs on a bearing about 5 degrees west of north, and dips to the west at an angle of about 45 degrees in the upper workings and 35 degrees in the lower; it has been opened up to a vertical depth of 300 feet and a total length of 600 feet as shewn by the accompanying section of the mine workings; as can be seen very little stoping has been done, especially from the lower levels.

Throughout the reef is very irregular, both in the upper and lower levels, and shews very little sign of improving at a depth; its average thickness is probably about five feet, but it varies from a mere thread up to 10 and 12 feet, and in one place along the 200 feet level is as much as 40 feet in thickness, but this is exceptional and is only a short bulge; the stone makes and cuts out very suddenly, often cutting out from 6 feet to almost nothing in 3 or 4 feet of distance; it is just as irregular vertically as it is laterally; the walls are not well-defined and consist of greenstone schist, there being three or four feet of this on the hanging wall and apparently about 30 feet on the footwall, the enclosing country being a fine-grained slightly foliated greenstone. The stone that has been taken out was from three to ten feet in thickness and there is still a great quantity of solid stone exposed along the drives; the bulk of this, however, *i.e.*, the remaining stone, is stated to be of very low grade and too poor to pay to work, most of the payable stone having been taken out. There are no defined shoots of gold, the bulk of the stone being, as just stated, extremely low grade with a few scattered patches of good stone. A patch of phenomenally rich stone occurred at the surface and some £20,000 worth of gold is said to have been taken out of a hole about ten feet deep; beyond this not a great deal has come out of the property.

A good deal of alluvial gold was obtained on the flat just below where the rich pocket was found in the reef; it was, however, only got over a small area and is now apparently worked out.

The main shaft on the property is sunk on the top of a hill, and the water level in the workings is 300 feet, the supply being salt; a good supply (salt) is obtained for battery purposes, etc., from a well on the flat half a mile to the north-west.

BULLETIN No 31.

PLATE VI

SECTION OF

THE WEALTH OF NATIONS G.M.

DUNNSVILLE
COOLGARDIE G.F.

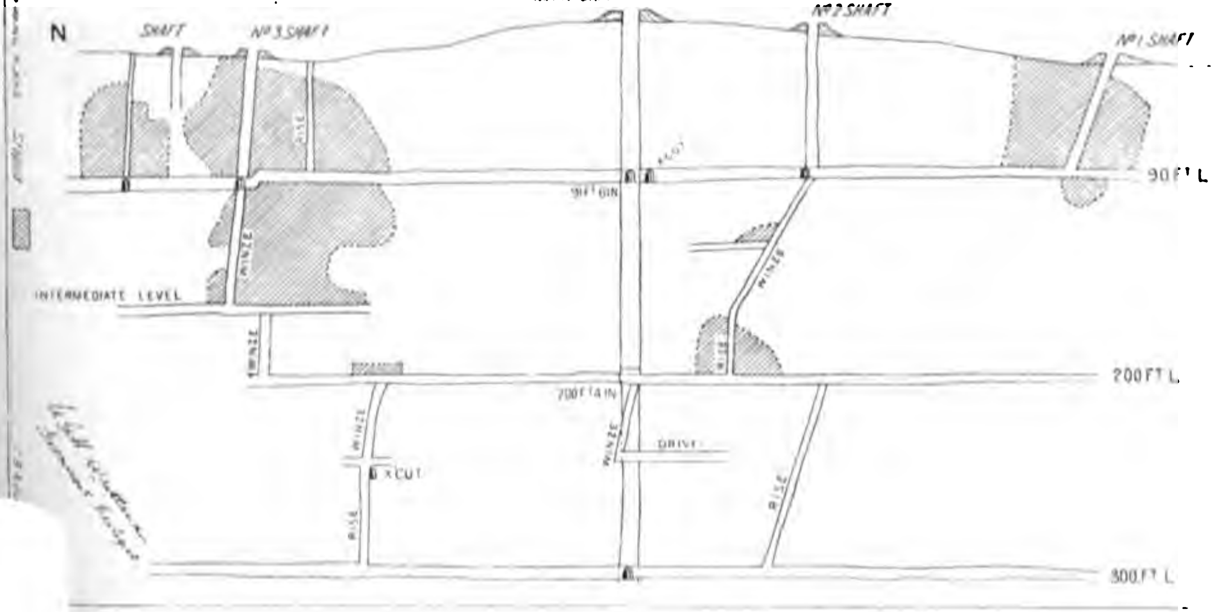


Table showing the Yield of the Wealth of Nations Reef.

Year.	Name and Number of Lease.	Ore crushed.	Gold therefrom	Rate per ton.	Total.		Average rate per ton.
					Ore crushed.	Gold therefrom	
		Tons.	Ozs.	Ozs.	Tons.	Ozs.	Ozs.
1898 ..	New Standard Exploration Co., Ltd., G. M.Ls. 17s (82s, 83s)	7,715·00	4,013·16	·52	13,681·00	5,788·52	·42
1899 ..	Do.	5,830·00	1,705·25	·29			
1901 ..	Do.	..	19·20	..			
1902 ..	Do.	136·00	50·91	·37			
1903 ..	Wealth of Nations, G. M.L. 17s (North Coolgardie G.Ms., Ltd.)	434·00	211·45	·48	1,758·00	786·56	·44
1904 ..	Do. .. .	994·00	233·16	·23			
1905 ..	Do.	330·00	99·01	·30			
1906 ..	Do.	..	cy. 119·37	..			
1907* ..	Do.	..	cy. 123·57	..			
	Total	..	..	..	15,439·00	6,575·08	·42

* To 30th June.

Table showing the Yield from Leases at Dunnsville, other than those already mentioned, up to 30th June, 1907.

Name and Number of Lease.	Ore crushed.	Gold therefrom.	Rate per ton.
	Tons.	Ozs.	Ozs.
Bellmont, G.M.L. 592s	98·00	93·26	·95
Bulletin, G.M.L. 617s	...	*49·72	...
Caroline, G.M.L. 86s	6·00	37·94	6·32
Central Wealth of Nations, Ltd., G.M.Ls. 58s, 113s	229·00	276·99	1·20
Easter, G.M.L. 577s	17·00	10·58	·62
Empress of the Jourdies, G.M.L. 449s	43·50	13·64	·31
Great Kangaroo, G.M.L. 686s ...	9·00	6·76	·75
Harp of Erin, G.M.L. 483s (449s)	82·00	40·38	·49
Jourdie, G M.L. 530s	415·00	159·19	·38
Jourdie Central, G.M.L. 774s ...	35·00	12·56	·37
Jourdie Hills Boulder, G.M.L. 582s	398·00	217·97	·54
Madame Berry, G.M.L. 503s ...	26·00	29·13	1·12
Madame Berry, G.M.L. 593s (503s)	15·00	8·11	·54
Masterton, G.M.L. 698s	29·00	20·68	·71

* Dollied and specimens.

Table showing the Yield from Leases at Dunnsville, other than those already mentioned, up to 30th June, 1907—continued.

Name and Number of Lease.	Ore crushed.	Gold therefrom.	Rate per ton.
	Tons.	Ozs.	Ozs.
Never Despair, G.M.L. 732s ...	13·00	5·69	·43
Nil Desperandum, G.M.L. 448s ...	10·00	4·49	·44
Queen of the Jourdies, G.M.L. 499s	29·00	16·05	·55
Sarmatia, G.M.L. 785s	...	*4·18	...
Shamrock, G.M.L. 496s	29·00	16·64	·57
South Boulder, G.M.L. 487s ...	20·00	9·87	·49
Sundry Claims	485·08	301·54	·62

* Dollied and specimens.

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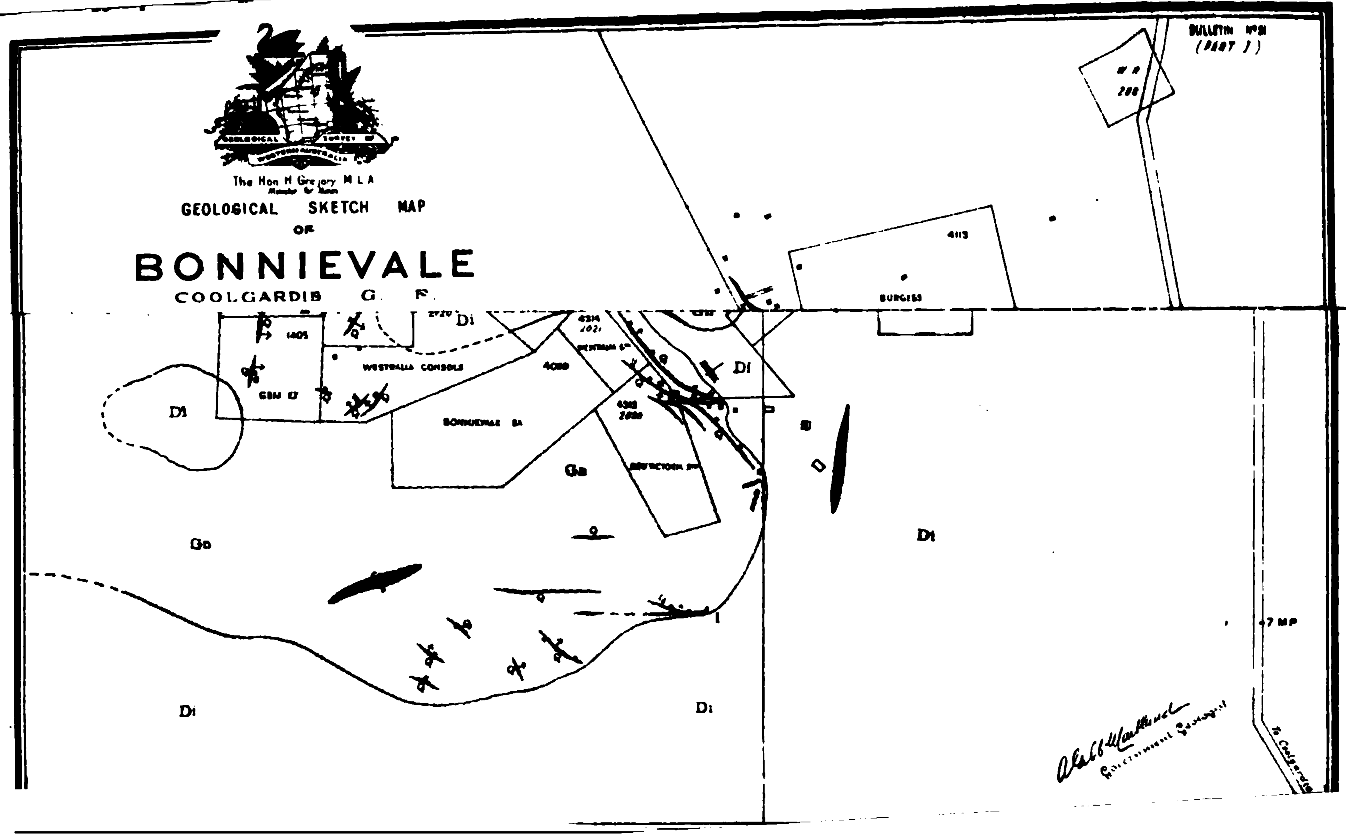The Hon H Gregory M L A
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To Coolgardie
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PART II.

THE

The Black Range District,

EAST MURCHISON GOLDFIELD.

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PART II.

The Black Range District, East Murchison Goldfield.

The Black Range Mining District is situated in the East Murchison Goldfield, lying about half way between Mt. Magnet and Lawlers. The present centre of the district is Sandstone, a town of recent date which has during the last couple of years completely supplanted the original centre Nungarra. Sandstone is reached by coach journey of about 100 miles from Mt. Magnet, the nearest railway station, and also from Lawlers, the former route being the main mail line, and coaches run both ways three times a week.

The district first came into prominence in the beginning of 1903, and since then has developed into an important field. It first gained importance as an alluvial centre, but when the alluvial began to be worked out attention was turned to reefing with the result that many good reefs were found, chief among them being those known as the "Sandstone" and "Hacks," (now the "Black Range"); these were first prospected early in 1903, and since then have developed into mines of considerable importance.

The first workings were at what was originally known as the "Patch," now called the "Six Mile"; a large amount of alluvial was obtained here, and one or two quartz reefs were worked, but though these are still struggling along they have not reached any importance. At about the time "The Patch" was shewing signs of being worked out "Hacks" reef and the "Sandstone" were found at what was then known as "Hacks," now the town of Sandstone; another good alluvial patch was also discovered and known as "Howies," and several reefs were also prospected in this neighbourhood; it was here that the townsite of Nungarra was afterwards laid out. This townsite was proclaimed on the 4th of December, 1903, and was the original centre of the district; as, however, mining developments at "Hacks" progressed a townsite was proclaimed at that place on 28th September, 1906, and was called Sandstone. Owing to the alluvial being worked out at Nungarra, and the reefs there not developing well, Sandstone rapidly superseded it as the principal town of the district, and is now a fairly busy place, while Nungarra is, practically speaking, dead.

Another centre that has come into some slight prominence in the district during the last three years is Maninga Marley, this place is situated some seventeen miles east-south-east of Nungarra along the Lawlers Road; there is no proclaimed townsite here, but several business areas have been reserved; there are two mines with 10-head batteries in the district, and several smaller ones in the prospecting stage.

Some twelve miles to the south west from Nungarra is what is known as Bellchambers, here a group of leases have been taken up and a little work is being done; so far, however, the locality is not a very important one.

The auriferous area is a fairly extensive one and is somewhat triangular in shape, having its apex at a point about nine miles north of Sandstone and then opening out southerly so as to include Bellchambers and Maninga Marley, and having here a maximum width of about twenty miles; it does not extend far south from either of these places and has a maximum length of about 25 miles. The rocks forming this auriferous area are greenstones of the usual type, and the belt is surrounded on all sides by extensive areas of granitic rocks (vide plan herewith).

Since its inception the Black Range Mining District has produced gold to the amount of 122,334·30 fine ozs.[*] as shown in the following table:—

Table showing the Total Gold Production from the Black Range District up to the end of 1907.

Year.	Alluvial.	Dollied and Specimens.	Ore treated.	Gold therefrom.	Total Gold.	Average per ton.
	Fine Ozs.	Fine Ozs.	Tons.	Fine Ozs.	Fine Ozs.	Fine Ozs.
Prior to 1897	...	...	...	...	...	...
1897	...	...	...	...	...	...
1898	...	...	12·15	13·42	13·42	1·10
1899	...	...	41·50	62·37	62·37	1·50
1900	...	...	138·00	91·65	91·65	·66
1901	...	...	38·00	13·84	13·84	·36
1902	...	69·76	43·50	122·38	192·14	2·81
1903	16·03	207·78	134·22	489·11	712·92	3·64
1904	135·70	61·61	7,183·16	10,989·08	11,186·39	1·53
1905	238·80	689·65	10,975·90	15,765·31	16,693·76	1·43
1906	477·78	639·81	20,581·58	34,302·70	35,420·29	1·66
1907	248·03	66·47	55,461·70	57,633·02	57,947·52	1·04
Totals	1,116·34	1,735·08	94,609·71	119,482·88	122,334·30	1·26

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he figures used throughout this bulletin have been supplied by the Statistical Branch of the Mines Department.

Previous Reports on the District.—The district has several times been reported on; first by myself in March, 1903, and several times since by the State Mining Engineer, these latter reports being in connection with the proposed railway from Mt. Magnet. My first report has been published in the Annual Report of the Geological Survey for the year 1903, and the State Mining Engineer's reports have appeared in the Annual Reports of the Department of Mines for the years 1904 and 1906. Numerous excerpts from these reports are made use of in the present work, but the full text of them should also be read in conjunction with it.

General Description of the Country.—Generally speaking, the country at Black Range is flat, with a few low ridges and numerous more or less isolated laterite capped hills, the so-called "breakaways." The greater part of the district is covered with loose surface soil and ironstone rubble, the former often attaining a considerable thickness on the low lying flats; these surface deposits naturally hamper prospecting to a great extent by concealing all outcrops.

These coverings of surface soil and ironstone rubble, together with the highly decomposed and weathered state of the rocks, render accurate mapping of the country a matter of practical impossibility, as even on the higher ground there is nearly always a thin deposit of loose ironstone rubble sufficient to conceal the exact nature of the underlying rocks.

There are but few rock outcrops in the district, and these are usually so weathered as to be almost unrecognisable.

The ridges are usually formed by the hematite quartz lodes which are so prevalent in the district, these having resisted the weathering action of the elements to a greater degree than the enclosing greenstones.

Both these hematite quartz lodes and the "breakaway" hills will be more fully described later.

General Geology.—The rocks comprising the auriferous belt are the usual type of greenstones (diorites, amphibolites, etc.), and are both massive and schistose; the latter type being found only in close proximity to the granite, the greater portion of the rocks being massive or only slightly foliated; they are intersected by occasional granite dykes and masses and also by numerous small basic (dolerite) dykes; the latter are not, as a rule, noticeable on the surface, owing to the fact that their outcrops are usually hidden beneath the recent deposits, and partly that they weather into a very similar form to the enclosing rocks. In addition to these acidic and basic dykes there is also a small area of volcanic rocks (hornblende-andesite) occurring near G.M.L.

13B (Chicago); there is only a comparatively small area of this visible, but in all probability there are other areas of it hidden beneath the recent deposits.

The greenstones are traversed by numerous hematite quartz lodes (locally called "ironstone" or "jasper" bars) which usually run in an east and west direction, although a few run north and south, and are very persistent; they appear to have a close connection with the quartz reefs of the district.

Deposits of laterite (ironstone conglomerate) are common throughout the district, usually forming the cappings of low hills and ridges.

The following is a more detailed description of the various classes of rocks found in the district:—

The Greenstones.—The so-called greenstones or amphibolites are hornblende rocks, mostly fairly coarse-grained and massive or only slightly foliated, except in close proximity to the granite where a strong schistosity is developed. Sections of them when examined under the microscope are seen to consist essentially of felspar and hornblende, the latter being, as a rule, a pale green variety and usually predominating over the felspar which appears to be albite; generally the hornblende is in large flakes, masses and imperfectly formed crystals, but often it occurs in acicular aggregates in intimate mixture with the felspar; ilmenite is always present in considerable quantity and, as a rule, the rocks show considerable alteration and decomposition, and calcite is frequently present in some quantities. The hornblende appears to be an alteration product of a colourless augite which is still present in some quantity in the specimens from the deeper levels, and this will probably prove to be the original essential constituent of these so-called amphibolites which should, therefore, more properly be classed as metasomasized pyroxenites.

These greenstones are usually very much weathered and softened down to considerable depths; on the Juno lease a specimen taken from a depth of about 300 feet is still fairly soft, and the constituents are much altered, chiefly by the action of percolating surface waters. They are traversed by numerous cleavage and fracture planes, the general trend of which is north and south and east and west; in the softer country within the upper water zone these cleavage planes, or "heads," become very "greasy" and the ground comes away very readily, and with the flat reefs of the district heavy timbering and close mullocking have to be resorted to in order to keep the underground workings safe.

Close along their junction with the granites, the greenstones are highly crushed and foliated, the foliations running parallel to and dipping away from the edge of the granite; the extent of the foliation is not well-defined, but its general width appears to be about twenty to thirty chains, sometimes more.

Within this foliation area are usually numerous small irregular granitic dykes, these being merely offshoots from the main body. A number of these dykes are seen where the Black Range Road first comes on to the greenstone area at Bellchambers.

At the surface the greenstones weather into soft red and yellow clays, this weathering continuing to a depth of well over a hundred feet before they begin to assume their natural and settled appearance; frequently at the surface they exhibit a slight schistosity, this, however, being merely a surface feature apparently caused by pressure due to expansion, and does not extend down to any depth.

The Granitic Rocks.—Excepting the main body of granite and its associated dykes, the only granitic rocks noted were those shown on the map at the Bull Oak and Worker leases. Both these outcrops are of comparatively small extent and their exact boundaries are not well-defined owing to the detrital deposits which cover most of the country here. Other similar, and possibly larger bodies, probably occur in the district, but they are hidden beneath the recent deposits.

These granitic rocks are very much decomposed, and down to the deepest depth exposed, about 120 feet, consist of a soft gritty kaolin, which is easily worked and stands well. Owing to this decomposition it is impossible to say what the original components of the rocks were but they (the rocks) are probably the same as the main granite body.

These two areas are undoubtedly intrusive into the greenstones and are of earlier date than the auriferous quartz reefs, which in one or two cases run continuously from one class of country into the other. The Bull Oak reef is a case in point; on the Bull Oak lease it is in granite and in the adjoining lease, the Maid Marion, it is in greenstone.

Andesite.—Just at the north end of G.M.L. 13B (Chicago) and about a mile to the south of the Bull Oak is a small area of hornblende-andesite; the visible extent of the outcrop is about forty chains by ten, having its greatest dimensions in a roughly east and west direction; it disappears at both ends beneath a capping of ironstone conglomerate, which in turn gives place to extensive areas of recent deposits, so that its actual extent may possibly be considerably greater than is shewn; as all the country to the south for some miles is covered with extensive recent deposits it is quite possible that there may be other areas of it hidden beneath them.

The rock itself is very close-grained, hard and compact; it is of a bluish green colour and breaks with a somewhat conchoidal fracture. It appears to be in every way similar to the andesite occurring at Cue Hill (Cue), and referred to by Mr. Woodward in Bulletin No. 29 of the Geological Survey. At Coorang, some forty miles south-south-west from Black Range, a fairly extensive area of a similar rock was noted by myself during a short visit to that centre in February, 1908.

The Basic Dykes.—These, as far as noted, are small and of later origin than the quartz reefs which, in several instances, they are seen to cut through. As stated before they are not distinguishable on the surface owing to the fact that they weather into exactly the same form as the enclosing greenstones. Several of them were cut in the underground workings of the Kohinoor G.M.L. 22B, and one also in the Oroya Black Range workings. These vary in thickness from one to seven feet, and consist of a dark fine-grained compact rock approaching an augite-dolerite in composition.

Dykes of this description are fairly common on the West Australian goldfields and have frequently been described in the publications of this Department.

The Recent Deposits.—These include both the laterites and the detrital deposits; these latter cover by far the greater part of the area examined, sometimes to a considerable depth and consist of sands, loams, gravels, etc., resulting from the gradual weathering down of the underlying rocks and the laterites by atmospheric agencies.

Laterite.—This occurs in more or less extensive areas throughout the whole district; in a compact and coherent state, it forms the capping of low hills and ridges, and as the result of weathering frequently exhibits vertical cliff faces twenty to thirty feet in height, these being locally known as "breakaways"; in a detrital and rubbly state it is scattered over large areas, but in these cases it has been classed with the sands, loams, etc., of the recent deposits.

When forming hill cappings these laterites can frequently be seen in a half-formed state, *i.e.*, a transition state between weathered greenstone and true laterite. Frequently also when capping ridges traversed by hematite quartz lodes, they are so closely mixed up with them in breaking down and re-cementing as to often have the appearance of a broken hematite quartz lode four or five chains in width. This breaking down and re-cementing of the hematite quartz lodes by the laterites also has the effect, on the surface, of apparently altering the line of strike of them and often renders them difficult to accurately follow.

As to the origin of these laterites it is now generally admitted that they are merely the result of decomposition *in situ* of the highly ferruginous greenstones, and are formed by the gradual concentration of the ferric oxide (resulting from such decomposition) by atmospheric agency.

Hematite Quartz Lodes.—These from a geological point of view are the most interesting feature of the Black Range district. They are specially numerous in the northern portion of the district mapped, *i.e.*, in the immediate neighbourhood of Sandstone and Hancocks, where they have a general east and west trend and an almost vertical dip; at Nungarra, and towards the "Six Mile," the general trend of the majority of these lodes is slightly west of north and east of south, though a few with an east and west strike are met with principally just to the north of Nungarra townsite.

In appearance and mode of occurrence these hematite quartz lodes are similar to those occurring in other parts of the Murchison and other West Australian goldfields, and which have frequently been described in the Geological Survey bulletins, but they differ from them in their relationship to the quartz reefs of the district.

As far as previous investigations have shewn the hematite quartz lodes of the Murchison and other parts have been of earlier formation than the associated quartz reefs, which in many cases cut through them, while in the Black Range district they are either contemporaneous with them or of later origin, probably the former.

These lodes are known locally as "ironstone, or jasper, bars" and are, as a rule, less ferruginous than the general Murchison type and consist principally of much laminated quartz and red to black jasper (ironstained quartz), the darker colours usually predominating, with occasional thin bands of hematite and magnetite. They are very persistent in their strike and can often be followed across country for several miles and right through have a very marked parallelism; on the surface they frequently exhibit an apparent lenticular habit owing to the irregular development of the banded quartz, but when these lenses die out the line of them is always marked by a strong schistosity in the greenstones.

These hematite quartz lodes are merely highly altered bands of schistose greenstone and at a depth will be found to lose the siliceous or "quartz" nature, and to pass gradually into narrow bands of crushed rock, probably with small veins of pyrites. In all likelihood they mark old fault lines, or thrust planes, and as such are probably deep-seated. On the assumption that they are thrust planes they probably have an intimate connection with the quartz reefs of the district, and this probable connection will be discussed later when the quartz reefs are being described.

These lodes are, as a rule, all more or less auriferous, but so far none of them have been sufficiently rich to pay to work.

Quartz Reefs.—As a general rule all the deposits being worked are clean quartz reefs, the principal exception being the Wirraminna, which is described later. Most of these reefs, especially those at the north end of the district, have a north and south trend and dip at a very flat angle, usually to the west. They are often of fair size and sometimes of considerable length, *e.g.*, the Sandstone (Oroya) and Black Range reefs; they almost invariably exhibit a strongly marked lenticular habit and are not, as a rule, characterised by clean or well-defined walls. The nature of the quartz itself varies a good deal, but it is mostly hard and white, and carries only a small amount of sulphides. In the oxidised portions of the Sandstone (Oroya) reef the quartz is of a peculiar friable and sugary nature, which will be more fully described when this mine is being dealt with.

At Sandstone and Hancocks the quartz reefs appear to have an intimate connection with the hematite quartz lodes ("ironstone bars"); they are almost without exception found abutting against the latter and generally have their strike approximately at right angles to that of the "bars;" at their contact with these they do not have the appearance of having been suddenly cut off by them, but give the impression that they have been formed at the same time and are part of the same system of fissuring or shearing. If it be assumed that the hematite quartz lodes mark old thrust planes, or main lines of shearing, caused by pressure, then the quartz reefs are probably secondary or induced fissures caused by these main thrust planes.

That main lines of fissuring do induce other lines at right angles has been proved by experiment by Daubree, the results of such experiments being described in Louis and Phillip's "Treatise on Ore Deposits," pp. 82 and 83.

An argument somewhat in favour of this theory is the fact that the reefs are strongest and best defined nearer but not at the "bars," but as they get farther away they become smaller d more irregular and gradually die out.

As the east and west "thrust planes" are undoubtedly deep-seated it is possible, but not necessarily so, that the quartz reefs are also deep-seated. Personally, however, I am of opinion that they will, as a rule, not be found to live long once hard-settled country is met with.

At the "Six Mile" the reefs differ from those at Sandstone and Hancocks, in that they are in no way associated with "ironstone bars," which are here conspicuous by their absence. Here the more important reefs run in a general north-easterly direction and have no regular dip; they are mostly of clean hard white quartz and appear to be normal fissure reefs; some of them are of considerable length, one line—the Groper—being traceable on the surface for about half a mile; they are mostly of fair size, but as far as developments have gone the shoots of gold appear to be very short and to cut out at a shallow depth.

Alluvial Gold.—A large amount of alluvial, or more correctly detrital, gold has been got in this district. The first "patch" of any importance was that at the "Six Mile;" when this began to be worked out other patches were found, the most important being Howie's, Shannon's, "Two-Mile Hill," and Hancock's. On all of these the gold appears to be pretty well worked out. As a general rule the gold was got only a foot or so below the surface —in many cases less—and was often in fair-sized pieces, though nothing very large was ever found. It appears to have been shed from small leaders and not from the reefs, as so far any of these worked near the patches have not proved to carry any exceptionally rich pockets.

Writing of these "alluvial" patches, Mr: Montgomery, the State Mining Engineer, who saw them at the time they were being worked, says*:—

> "In the 'Two Mile' and 'Howie's' patches much of the gold was "enclosed in cemented brown iron ore, requiring milling for its extraction. "This gold is frequently crystalline and angular, and has evidently been "deposited in the ironstone from solution, not carried into it mechani- "cally. A good deal of the gold won from these deposits appears there- "fore in the gold returns as obtained from ore by milling, not as alluvial.
>
> "At the time of my visit, April, 1906, the principal work at the "'Two Mile Hill' was that of Messrs. Kelly and party on the south slope "of the hill. They have done a large amount of work prospecting for "deep alluvial ground, and for reefs below the alluvial. Seven shafts "have been sunk to depths of from 45 to 70 feet, and Mr. Kelly informed "me that the drives therefrom would total over 1000 feet in length. The "alluvial ground is mostly concretionary, of pisolitic brown iron oxide, "and is up to 40 feet in depth, below which is much weathered green- "stone country, with frequent quartz veins. The ironstone is often gold "bearing, and Mr. Kelly told me from his prospecting it he considered

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* Annual Report of the Department of Mines for the year 1906, p.80.

"that a large amount of it would pay to crush if he had a battery on the "ground. Some of it was crushed by hand by the dryblowers and treated "in their shakers. . . . . It is impossible to form a decided "opinion as to the amount of payable material available at this place "without very careful and extended sampling, but there seems reason to "think that with cheap milling facilities on the spot a large tonnage of "low-grade material might be successfully treated."

Water.—Water is abundant throughout the district, and the supply is fresh. On the low-lying portions it is usually met with at a depth of from 50 to 70 feet.

Timber.—The only timber available locally is mulga, and the better quality of this is rapidly becoming exhausted. A little gum timber is obtainable from the edge of the lake country about forty miles to the north, but the supply of this is very limited, and it is being repidly cut out.

As the country is very soft and rotten, and the reefs are very flat, extensive timbering is required in the mine workings, and the timber trouble is becoming a serious item with the mining companies. At the present time good gum timber costs up to 2/6 a foot, and smaller timber is proportionately as expensive.

THE MINES.

The following are brief descriptions of the principal mines in the district:—

NUNGARRA.

At Nungarra no work of any importance was being done at the time of my visit; the Wirraminna had just closed down, and no work was being done on this line; a little was being done at the "Two Mile Hill," and there were one or two prospecting parties working, but no systematic work was being done anywhere.

Wirraminna Central, G.M.L. 182B.

This lease is the property of the Sandstone Development Company; owing to unsatisfactory developments, mining operations were suspended a few days before my arrival, and I was unable to inspect the workings. Since the company ceased operations tributers have been at work in the upper levels, and have taken out some very fair stone.

Mr. Montgomery in his report* in 1906, makes the following statements about this property—

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*Annual Report of the Department of Mines for the year 1906.

only being "rooted" near the surface. One or two leaders were being worked, but several of the old shows on the larger reefs had been abandoned, developments not having been satisfactory.

Groper, G.M.L. 1B.

This lease was originally worked in the beginning of 1903, since when it has several times been abandoned and retaken up; on the whole, very little work has been done on it, as results are said not to have been satisfactory, the better values being stated to have cut out at a shallow depth, and the bulk of the stone is too poor to pay to crush. The deepest workings are said to be only about 60 feet, but a good deal of "rooting" has been done near the surface.

Two well-defined parallel lines of reef run through the property on a bearing about north-east and south-west, dipping fairly flat to the south-east; these are very persistent on the surface, the main, or east, reef being traceable for over half a mile.

In the old workings it appears to have averaged two to three feet in thickness and consists of clean, hard, white glassy quartz. The stone carries a small percentage of copper (as carbonate) as well as a little zinc blende, these usually being associated with good gold values. For the greater part of its length this reef is in greenstone, but in the present workings it comes in contact with a small granitic dyke which for a short distance forms the hanging wall of it and also for a short length completely encloses it; this dyke is only a few feet in width and is not noticeable on the surface owing to the amount of debris which covers it.

At the present time the owners are working the reef near the surface where it comes into contact with the dyke and where the values are said to be slightly better; most of the ore being broken consists of rotted granite with seams of quartz through it, and is on the hanging wall of the reef proper; the width of this varies from a few inches to three feet.

Table showing the Yield of the Groper Lease.

Year.	Name and Number of Lease.	Ore crushed.	Gold therefrom	Rate per ton.	Total.		Average rate per ton.
					Ore crushed.	Gold therefrom	
		Tons.	Ozs.	Ozs.	Tons.	Ozs.	Ozs.
1902 ..	Groper, G.M.L. 1B (339)	1·50	19·56	13·04	..	..	..
1903 ..	Do.	5·50	4·66	·85	..	..	..
1904 ..	Do.	116·00	140·69	1·21	..	..	..
					123·00	164·91	1·34
1905 ..	Groper, G.M.L. 179B(1B)	..	..	..	35·25	133·15	3·78
	Total ..	..	..	..	158·25	298·06	1·88

Black Range Main Reef, G.M.L. 3B. (Formerly known as "the Butchers").

This property was one of the first worked in the district, but not a great deal has been done on it, and at the present time it is abandoned. The State Mining Engineer, who examined the property in 1906, reports on it as follows*:—

> "A strong quartz reef, about four feet thick, runs north-easterly "through the lease, and has been proved gold-bearing at several points "along its outcrop for about 400 feet in length. Several shafts have "been sunk to water level, about 64 feet, ... and a main "vertical shaft was sunk to 107 feet and a crosscut put in to the reef at "100 feet. The reef was cut in the crosscut . . . . but had not "been driven upon. The quartz vein was from six inches to two feet "wide where cut, but the hanging wall seemed much shattered, and the "whole width of the lode channel is probably a good deal greater.
>
> "The quartz was rather poor where cut, but I have no doubt that "driving on the reef will soon be successful in finding better ore corresponding to the shoot from which the crushings were taken. . . . . "The water is fresh and drinkable."

Table showing the Yield of the Black Range Main Reef Lease.

Year.	Name and Number of Lease.	Ore crushed.	Gold therefrom.	Rate per ton.
		Tons.	Ozs.	Ozs.
1903	Black Range Main Reef, G.M.L. 3B	15·00	21·37	1·42
1904	Do.	107·25	165·86	1·54
1905	Do.	10·50	23·70	2·26
	Total	**132·75**	**210·93**	**1·59**

Eclipse, G.M.L. 211B.

This lease is situated about three miles south-east from the Black Range Main reef, along the Lawlers Road. The property was under exemption at the time of my visit, and the workings were inaccessible.

There is a fairly well-defined line of reef running through the lease on a bearing slightly north of west and south of east, having practically a vertical dip. A main vertical shaft has been sunk on this reef and is said to be 180 feet in depth; there is said to be a strong quartz reef at the bottom two feet wide and carrying good values. A few chains east of the main shaft is a small hematite quartz lode running north-west and south-east across the line of the reef; good values may possibly be met with at the point of intersection of the two, but so far, apparently, no effort has been made to see if such exist.

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* Annual Report of the Department of Mines for the year 1906.

Water level is about 100 feet, and the supply is fresh; water is said to be very plentiful, and the prospectors were unable to cope properly with it with the limited means at their disposal.

Writing of this property in 1906, the State Mining Engineer, says*:—

> ". . . . . There is a well-defined quartz vein with smooth clean walls, in weathered greenstone schist; the average width of the ground stoped has been about fifteen inches of quartz and twenty-four inches from wall to wall, but in the bottom of the shaft it seems to have a tendency to increase; . . . . it has been driven on at the 100 feet level for about 200 feet, and has been stoped for about 85 feet in length up to 25 feet from the surface, where it becomes rather poor.
>
> " South-east from the shaft, about 150 feet, there is a large lode of brown iron oxide and quartz which has been cut in a shallow costeen, and runs about north-west and south-east. This is also cut in a shaft 40 feet deep; . . . . it contains a little gold, estimated by the prospectors at about six dwts. per ton. The quartz reef worked in the shaft should intersect this one, and as the junction has a fair chance of being richer than elsewhere; it should be located if possible. . . . . ."

Table showing the Yield of the Eclipse Lease.

Year.	Name and Number of Lease.	Ore crushed.	Gold therefrom.	Rate per ton.
		Tons.	Ozs.	Ozs.
1905	Eclipse, G.M.L. 211B ...	62·75	78·08	1·24
1906	Do.	74·50	27·88	·37
1907	Do.	184·00	123·43	·67
	Total	**321·25**	**229·39**	**·71**

Prendergasts.

A couple of miles north of the Eclipse, Messrs. Prendergast and party are prospecting a large hematite quartz ("jasper") lode. This runs on a bearing slightly north of west, and has a practically vertical dip; it is over a chain in width in places, and outcrops for half a mile or more. At the spot the gold was found in the lode it is very much broken and faulted, and seamed with small veins of quartz; there is also an irregular vein of quartz running along the north side of it.

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* Annual Report of the Department of Mines for the year 1906.

An opencut, ten or twelve feet in depth, has been put across the lode, and shows a mixture of quartz and jasper much broken and faulted. The gold appears to be principally in the quartz and along or close to the cross faults. A vertical shaft is now being sunk with the object of cutting the lode at water level.

There is certainly a hugh body of ore in this property, but its chance of proving payable in any quantity is, I fancy, very remote.

SANDSTONE.

At Sandstone all the more important work of the district is being done, and matters are pretty brisk. The three big mines of the district are situated here, viz., the Black Range, the Oroya Black Range, and the Sandstone Development. In addition to these there are a number of smaller shows working, chief among these being the Wanderie leases.

Wanderie and Wanderie West, G.M.Ls. 8B, 23B.

The same line of reef has been worked on both of these leases, and a lot of work has been done on it above water level. The deepest workings are on the Wanderie, the main shaft being down 220 feet; the reef has been opened up at the 200 feet level for a length of about 100 feet, but the owners were unable to properly cope with the water and are now working above water level.

On the Wanderie lease the reef has been opened up at the 120 feet level for a total length of well over 400 feet; its average width throughout the workings is stated to have been about three feet, but it is very irregular, varying from a few inches up to as much as seven feet, and occasionally cutting out altogether.

Along the 120 feet level there is practically no stone, but it makes a few feet above the level; this break, probably due to a strike fault, is continuous through both leases; along the 200 feet level the reef is said to be fairly strong again and of pretty good value.

The general trend of the reef is slightly south of west and north of east; in the upper levels it underlies slightly to the south, but at a depth is practically vertical. It runs along the southern side of a small hematite quartz lode; this, on the surface, has the usual laminated appearance of these lodes, but at a fairly shallow depth it turns into a much weathered greenstone schist, with occasional small seams of quartz and ironstone in it; occasionally the schist is found on both sides of the reef, but, as a rule, it is only on the north side; this schist with its accompanying quartz and ironstone veins is said to carry a little gold, but not sufficient to pay to work.

The main reef is of clean, white, solid quartz, and has probably been formed along a fault line following the original line of the hematite quartz lode.

On the Wanderie West, the workings are all above water level (125 feet), and the reef is said to have averaged about three feet in thickness; it has the same irregular habit here as in the Wanderie, varying from a few inches up to six and seven feet.

The water supply is fresh, and is said to be about 3000 gallons per hour; it comes in only along the line of the reef and the schists.

Table showing the Yield of the Wanderie Leases.

Year.	Name and Number of Lease.	Ore crushed.	Gold therefrom	Rate per ton.	Total.		Average rate per ton.
					Ore crushed.	Gold therefrom	
		Tons.	Ozs.	Ozs.	Tons.	Ozs.	Ozs.
1904 ..	Wanderie, G.M.L. 8B ..	648·25	1,000·06	1·54			
1905 ..	Do.	382·00	879·97	·99			
1906 ..	Do.	367·75	348·58	·94			
1907 ..	Do.	622·00	386·20	·62	2,020·00	2,114·81	1·05
1904 ..	Wanderie No. 1 West, G.M.L. 23B	159·75	94·69	·59			
1905 ..	Do.	169·25	116·97	·69			
1906 ..	Do.	936·50	694·17	·74			
1907 ..	Do.	397·00	143·25	·36	1,662·50	1,049·08	·63
	Total	..	..	..	3,682·50	3,163·89	·8

Wanderie No. 1 North, G.M.L. 161B.

A good deal of work has been done on this lease down to water level, but it was idle at the time of my visit and could not be inspected. A small north and south quartz reef has been worked; this is said to have been from ten to twelve inches in thickness, and fairly regular. It is cut off at the south end by the Wanderie line, and apparently does not run very far north. Its dip is said to have been about vertical.

Table showing the Yield of the Wanderie No. 1 North Lease.

Year.	Name and Number of Lease.	Ore crushed.	Gold therefrom.	Rate per ton.
		Tons.	Ozs.	Ozs.
1905	Wanderie No. 1 North, G.M.L. 161B	149·00	163·55	1·10
1906	Do.	424·00	342·96	·81
1907	Do.	87·00	34·23	·39
	Total	**660·00**	**540·74**	·8

About a mile to the south-west of the Wanderie one or two small quartz leaders have been and are being worked. These are of no great importance, and not much is being done on them.

Black Range Gold Mine, G.M.Ls. 4B, 5B, 9B, 11B, etc.

The reef on this property was the first worked at this end of the field; it was found about the beginning of 1903, and was originally known as "Hack's."

A reference to the underground plans (Plate 1) will show the amount of work that has been done up to about the end of last year.

The reef runs almost due north and south, and dips to the west at an angle of about 35 degrees. It is of clean solid quartz, but is very irregular and lenticular, especially in the upper levels. These lenses range in thickness up to seven and eight feet, but their length and depth are very variable; when they cut out their place is taken by a somewhat schistose greenstone, and the difference between the different lenses, both longitudinally and vertically, is as variable as the length of the lenses themselves, sometimes being only a few feet and sometimes up to as much as a hundred feet The walls of the reef, taking it right through, are not good, and are not well-defined. The country on each side of the reef is soft and rotten, especially on the hanging wall, and requires extensive timbering; in the bottom of the main shaft the country is a fairly hard massive greenstone, but for from fifteen to twenty feet on each side of the reef it is much softer and more weathered. The deepest workings are still in the oxidised zone, and the values are said to be fairly uniform throughout.

About 100 feet north of the main shaft is a large hematite quartz lode, running about east and west and dipping vertically. The reef gradually dies out on approaching this, and although a lot of work has been done to the north of the "bar" in the hopes of picking up the continuation of the reef, it has, so far, not met with success; a few small seams of quartz were certainly met with, but they were of no size and of no importance; personally I am inclined to the belief that no continuation of the reef will be found in this direction.

The values in the main reef are said to stop ten or twenty feet away from the bar, and not to come right up to it, though at times the quartz does so; just before they stop, however, they are said to be a good deal higher than the average.

The "bar" on the surface consists of laminated quartz and ironstone, but gradually changes in depth, and in the lower levels consists of highly schistose greenstone, with seams of ironstone and a little quartz; it carries no appreciable gold values.

The water supply of the mine is fresh, and is said to be sufficient for all present requirements; the water comes in along the line of the reef and also, heavily, along the line of the "ironstone bar."

Table showing the Yield of the Black Range Gold Mine Leases.

Year.	Name and Number of Lease.	Ore crushed.	Gold therefrom	Rate per ton.	Total.		Average rate per ton.
					Ore crushed.	Gold therefrom	
		Tons.	Ozs.	Ozs.	Tons.	Ozs.	Ozs.
1903 ..	Adelaide, G.M.L. 4B (674M)	14·00	131·43	9·38			
1904 ..	Do.	2,580·00	5,142·90	1·99			
1905 ..	Do.	4,849·00	7,408·82	1·53	7,443·00	12,683·15	1·7
1906 .	Adelaide Leases, G.M. Ls. 4B, 5B, 11B, 17B, 26B, 70B, 140B, 150B	7,990·50	14,076·02	1·76			
1907 ..	Do.	13,019·50	16,179·26	1·24	21,010·00	30,255·28	1·
1903 ..	Black Range, G.M.L. 5B (676M)	..	*152·68	..			
1904 ..	Do.	637·00	1,283·66	2·01			
1905 ..	Do.	..	194·00	..	637·00	1,630·34	2·5
1907 ..	Black Range Mining Co., N.L., G.M.Ls. 4B, 5B, 9B, &c.	..	..	..	1,488·00	2,165·30	1·
	Total	..	..	..	**30,578·00**	**46,734·07**	1·5

* Dollied and specimens.

Oroya Black Range, G.M.Ls. 6B, 10B, 16B, 74B, 114B, etc.

The reef on this property is in general characteristics similar to that in the Black Range Company's leases, that is to say, it is a flat quartz reef with marked lenticular habit. The general trend of this reef is roughly north and south, and it dips at an angle of about 25 degrees to the west; near the surface its dip is about 45 degrees, but it gets flatter below the No. 1 level. Its average thickness can be said to be from three to four feet, though it is as much as eight and ten feet in places, but this bulging is counteracted by the fact that it frequently pinches out to a few inches and occasionally cuts out altogether; these breaks are, however, not of frequent occurrence and are, as a rule, of no length, and the quartz can almost be said to be continuous throughout the whole of the workings, though of course very variable in size and, in places, a good deal broken.

At the south end of the workings the reef is small and very broken, though the actual end of it has not yet been reached. approching the north end it also becomes more lenticular and irregular, and splits up a good deal, but the end of it has not nearly been reached in this direction yet, as proved by the workings on the adjoining company's leases. At this north end in the bottom levels; this is from one to seven feet in th djoining company's leases. At this north frequent splits go off into the footwall, these on being followed either come back again into the main line or else die out; it would appear that the general line of the reef is here turning slightly more to the westward.

Occasionally the reef shews clean well-defined walls, but, as a rule, they are not good, the footwall being, usually, anything but well-defined, small quartz veins and stringers running off from it in all directions into the enclosing country.

The quartz in the bottom level is mostly hard and compact, and of a slightly bluish tinge; occasionally, however, it exhibits the friable nature so characteristic of the upper levels; along the No. 2 level it is both solid and friable, whilst above this it is almost entirely of a friable sugary nature and crumbles readily between the fingers; it was this that gave the reef its original and better-known name of "the Sandstone."

As to the cause of this friable nature of the stone two possible origins have been put forward, viz., (1) leaching and (2) pressure. With regard to the former it has been suggested that the original quartz of the reef may have been partly crystalline, *i.e.*, insoluble, and partly hydrous, *i.e.*, soluble, under certain conditions, and that in the upper or oxidised portions the soluble quartz had been leached out; this theory arose owing to the fact that the friable quartz when closely examined exhibits its true crystalline form to a marked degree. Samples of the solid quartz from No. 2 level were examined and found to contain only a trace of soluble silica, and this fact seems to explode the leaching theory and to leave only that of "pressure;" undoubtedly great pressure could be caused by the expansion of the surrounding rocks during hydration, and it appears that this must be taken as the most probable cause of the extreme friability of the quartz in the upper levels.

There is no defined shoot of gold in the reef, but the stone is not all of uniform value, the gold appearing to occur in small irregular patches right through the reef.

The country is massive greenstone, and is still soft and rotten in the deepest workings; it is full of "greasy" heads, or cleavage planes, and is very "heavy" and treacherous, and owing to the flat dip of the reef requires very extensive timbering. As good mining timber is very scarce in the district this item is one of the most serious that the Company have at present to contend with.

Water is fresh and the supply is plentiful, and is still coming in at the bottom level.

A small basic (dolerite) dyke runs along and crosses the reef in the bottom levels; this is from one to seven feet in thickness, and cuts through the reef without displacement of any kind. A good flow of water comes in along the line of this dyke.

Table showing the Yield of the Oroya Black Range Leases.

Year.	Name and Number of Lease.	Ore crushed.	Gold therefrom	Rate per ton.	Total.		Averag rate per ton.
					Ore crushed.	Gold therefrom	
		Tons.	Ozs.	Ozs.	Tons.	Ozs.	Ozs.
1904 ..	Sandstone, G.M.L. 6B	424·75	378·92	1·60			
1905 ..	Do.	737·25	915·78	1·24			
1906 ..	Do.	277·50	343·84	1·26	1,439·50	1,938·54	1·
1904 ..	Undaunted, G.M.L. 10B	..	..	..	80·00	46·04	·
1904 ..	Undaunted East, G.M.L. 74B	198·75	213·50	1·07			
1905 ..	Do.	204·50	217·79	·74			
1906 .	Do.	155·00	188·53	1·21	648·25	619·82	
1905 ..	Undaunted East Extended. G.M.L. 114B	166·25	72·76	·44			
1906 ..	Do.	109·75	108·58	·99	276·00	181·34	
1905 ..	Golden Gate, G.M.L. 149B	..	..	..	113·75	62·98	
1905 ..	Golden Key, G.M.L. 151B	349·50	457·33	1·31			
1906 ..	Do.	533·50	955·42	1·79	883·00	1,412·75	1
1904 ..	Kingoonya, G.M.L. 16B	121·50	209·33	2·46			
1905 ..	Do.	408·00	739·22	1·81			
1906 ..	Do.	876·50	811·85	·93	1,406·00	1,850·40	1
1906 ..	Oroya Black Range, Ltd., G.M.Ls. 6B, 10B, 16B, &c.	1,646·00	1,917·00	1·16			
1907 ..	Do.	19,521·00	13,059·26	·67	21,167·00	14,976·26	
	Total	..	..	..	**26,013·50**	**21,088·13**	

Sandstone Development Co., G.M.Ls. 174B, 187B, etc.

This Company hold the blocks containing the deep levels the Oroya reef as well as blocks farther north along the outcro At the present time work is being concentrated on the Ju lease, where the reef comes into the property, at a depth of ab 180 feet.

A good deal of work has also been done on the Wono lease, where some good values were obtained near the surfa the work on this lease proves the reef to have a total leng of well over half a mile, and it probably extends still fart north though it is getting smaller and more broken in t direction.

Where worked on the Wonoka, the reef is very irregul varying from a few inches to six feet; in a winze, from the 1 feet to the 180 feet level, it averages three to four feet, a is said to carry very fair values; some very good stone has b

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Where worked on the Wonoka, the reef is very irregular, varying from a few inches to six feet; in a winze, from the 110 feet to the 180 feet level, it averages three to four feet, and is said to carry very fair values; some very good stone has been taken out of these workings, but the occurrence of the gold is very patchy. The reef here owes its broken nature a good deal to the presence of a large flat quartz reef which cuts across it and throws it about somewhat; this reef is of hard white glassy quartz, and carries no values.

On the Juno lease the reef has been cut at a depth of 200 feet; what work has been done on it here shews it to still maintain its lenticular habit, sometimes cutting out altogether, and at others making into solid bodies of quartz up to six feet in thickness; the values here are somewhat erratic, but, on the whole, the reef is stated to be highly payable.

Table showing the Yield of the Sandstone Development Co.'s Leases

Year.	Name and Number of Lease.	Ore crushed.	Gold therefrom	Rate per ton.	Total.		Average rate per ton.
					Ore crushed.	Gold therefrom	
		Tons.	Ozs.	Ozs.	Tons.	Ozs.	Ozs.
1906 ..	Wonoka, G.M.L. 174B	68·50	36·35	·53			
1907 ..	Do.	165·00	156·12	·95			
					233·50	192·47	·82
1907 ..	Venus, G.M.L. 251B ..	..	..	..	36·00	3·27	·09
1907 ..	Sandridge, G.M.L. 187B	..	.	..	226·00	91·19	·40
	Total	..	..	..	**495·50**	**286·93**	**·58**

HANCOCKS.

A number of leases are being worked here but mostly only by small parties. The reefs are, as a rule, all fairly small and lenticular; they are, with one exception—the Kohinoor—all quartz reefs, and have a general north and south trend, dipping, as a rule, at a flat angle to the east. They are all intimately connected with the hematite quartz lodes ("ironstone bars") and, as before suggested, appear to owe their existence to the presence of these. The gold in them usually occurs in irregular shoots, and is not, as a rule, evenly distributed through the stone. In no case do they possess well-defined walls and, as a rule, they do not give the impression of being likely to prove permanent.

Owing to the amount of talus and debris covering the surface in this neighbourhood, prospecting is rendered difficult. It appears likely, however, that other payable (to a certain depth) reefs should be found here, and also other bodies similar to that now being worked on the Kohinoor, as there are, possibly, numbers of these flat lying fissures which do not reach the surface; these, however, would only be found in sinking or crosscutting and, in all probability, accidently as was the case in the Kohinoor.

With the exception of the Kohinoor no work has been done below water level on any of the leases.

Bull Oak, G.M.L. 382B.

The reef on this property runs a little west of north and east of south, and dips to the east at an angle of about 45 degrees.

On the Bull Oak lease this reef is entirely in granite, as shown on the map, but just outside the southern boundary of the lease it runs into the greenstone, and in the adjoining property has been worked in both classes of country. It has been opened up to a depth of about a hundred feet, and has an average thickness of from 20 to 30 inches; while in the granite it is fairly regular in size, but in the greenstone it becomes smaller and more broken, and the values also decrease considerably. Above the 100 feet level the values are said to have been fairly regular, and as can be seen by reference to the returns were of high grade.

The country is soft and easily worked, and stands well.

Table showing the Yield of the Bull Oak Leases.

Year.	Name and Number of Lease.	Ore crushed.	Gold therefrom.	Rate per ton.
		Tons.	Ozs.	Ozs.
1907	Bull Oak, G.M.L. 382B	725·00	956·77	1·32
1907	Comrades Leases, G.M.Ls. 369B, 379B, 382B	1,094·00	930·12	·85
	Total	**1,819·00**	**1,886·89**	**1·03**

Maid Marion, G.M.L. 383B.

In this lease which adjoins the last on the south the reef is, as stated above, partly in the granite and partly in the greenstone; in the granite it is a couple of feet in thickness and of fairly high grade, but in the greenstone it is small, broken and irregular, and of low grade. The walls of the reef on both leases are not well-defined even in the granite, while in the greenstone they are very bad; small stringers run off into both walls and, in the greenstone, veins and masses of siliceous ironstone form along the walls, these being very hard and of no value.

The total length of the reef in both leases is not much more than five chains, and it does not show any signs of permanency; moreover, the high values obtained in the upper levels are not likely to continue down to any depth.

From this lease 373 tons were crushed during 1907, for a return of 492·87 ozs., being at the rate of 1·32 ozs. per ton.

Lady Ellen, G.M.L. 139B.

This lease is situated about half a mile south-east of the Bull Oak. A small north and south quartz reef runs through the property, dipping at an angle of about 45 degrees to the east. This reef has been worked to a depth of about a hundred feet and for a length of over two hundred feet; it is from fifteen inches to two feet in thickness and fairly regular, consisting of clean solid quartz. The values are very variable, and the stone is to a certain extent being picked, but this is rendered difficult owing to the fact that the gold does not occur in regular shoots. At the south end the reef is terminated by a large east and west "ironstone bar" which runs across country for some considerable distance; no sign of it has been found south of this bar.

The outcrop of the reef is concealed beneath surface debris, and it is impossible to follow its northern extension; in all probability, however, its total length is not more than six or eight chains, as at about this distance from the "bar" at the south end are several other east and west bars which would cut it off if it extended that far.

Table showing the Yield of the Lady Ellen Leases.

Year.	Name and Number of Lease.	Ore crushed.	Gold therefrom.	Rate per ton.	Total.		Average rate per ton.
					Ore crushed.	Gold therefrom	
		Tons.	Ozs.	Ozs.	Tons.	Ozs.	Ozs.
1905 ..	Lady Ellen, G.M.L. 139B	107·00	208·02	1·94			
1906 ..	Do.	112·75	250·94	2·22			
					219·75	458·96	2·09
1906 ..	Lady Ellen Leases, G.M. Ls. 139B, 234B	..	..	..	100·00	138·39	1·38
	Total	..	..	..	**319·75**	**597·35**	**1·83**

Freedom, G M.L. 337B.

The reef here runs north and south, and dips east at a flat angle. It is very irregular, both in size and values; its average thickness is about two feet, but it reaches as much as four feet; it is not a clean quartz reef, but consists of a mixture of quartz with crushed and weathered greenstone, there being occasional fairly continuous bodies of solid quartz in it; there are no defined walls to this reef.

On the north the reef ends against a large east and west ironstone bar; a good patch of stone was got just near this but it was of no size; a similar bar occurs about eight chains farther south so that the reef cannot have a great length; its actual outcrop is not visible, but its length is probably not more than five or six chains, and it does not appear likely to live to any great depth.

In 1907, there were crushed from this lease 332 tons for a yield of 520·18 ozs. of gold, being at the rate of 1·56 ozs. per ton.

New Sensation Leases, G.M.Ls. 365B, 366B.

On these leases a small but rich quartz vein has been worked to a depth of about 130 feet. This vein runs about north-west and south-east, and dips steeply west; it is on the north side of a small ironstone bar five or six feet thick; a small make of quartz has also been picked up on the south side of this bar and may, or may not, be the same vein as that worked on the north side; it is certainly much smaller and poorer.

The vein worked is from six to fifteen inches in thickness, and the gold is said to occur only over a length of about 40 feet, just on the north side of the bar, the remainder of the stone being stated to be of no value.

Table showing the Yield of the New Sensation Leases.

Year.	Name and Number of Lease.	Ore crushed.	Gold therefrom.	Rate per ton.
		Tons.	Ozs.	Ozs.
1907	New Sensation, G.M.L. 365B	163·00	380·89	2·34
1907	New Sensation Leases, G.M.Ls. 365B, 366B	126·00	135·77	1·08
	Total	**289·00**	**516·66**	**1.78**

Black Range Kohinoor Mining Co., G.M.Ls. 22B, etc.

Two distinct lines of reef have been worked on this property; the original one was a quartz reef, striking north and south, and dipping at a flat angle to the east; this has been opened up to a depth of 160 feet, but most of the work done is above the 100 feet level; it averages from eighteen inches to two feet in thickness, and is pretty regular; the shoot of gold worked is said to have been only about 40 feet in length; in the deepest workings (160 feet) the stone is from two to two and a half feet in thickness, but is said not to carry very good values. This reef at its south end abuts against a large ironstone bar running about east and west; its northern extension cannot be followed very far on the surface, but it probably does not extend far, as there is another large bar six or eight chains farther on in this direction, which would cut it off if it reached so far.

The vein at present being worked is also roughly north and south in its strike, but dips to the west, also at a very flat angle.

It does not outcrop, but runs into the main reef at about 30 feet from the surface. The shoot of gold is said to be about 80 feet in length, and at first follows down alongside the south ironstone bar, but at a depth of 90 feet or so it turns and pitches away north-west. The values in this shoot are much better than those found in the main reef; the width of the stone varies from a few inches up to five feet, probably averaging between two and three feet. This vein is not a solid quartz reef but consists of a mixture of altered greenstone and quartz, often with good sized bodies of solid quartz; there are no defined walls to the ore body, the width of the crushing stone being decided only by assay values.

The vein appears to have been merely a small fissure through the country along which gold and silica-bearing solution have had access, and have impregnated the softened country on either side, the quartz masses marking points where the fissure has widened. These quartz masses are, as a rule, of much lower grade than the balance of the ore body.

The country is a massive greenstone, very soft and weathered down to about 150 feet; in the bottom of the water shaft (170 feet) it is fairly hard and compact.

Several small basic dykes were cut in the workings on this property; these appear to run about east and west, and are from two to ten feet in thickness; they cut right across the reefs but do no harm and are of no importance.

Table showing the Yield of the Black Range Kohinoor Mining Co.'s Leases.

Year.	Name and Number of Lease.	Ore crushed.	Gold therefrom.	Rate per ton.	Total.		Average rate per ton.
					Ore crushed.	Gold therefrom.	
		Tons.	Ozs.	Ozs.	Tons.	Ozs.	Ozs.
1903 ..	Sceptic, G.M.L. 300B ..	..	..	..	..	*3.75	..
1904 ..	Kohinoor, G.M.L. 22B ..	18·50	28·47	1·54			
1905 ..	Do.	114·50	95·32	·83			
1906 ..	Do.	198·25	998·60	5·04	331·25	1,122·39	3·39
1907 ..	Black Range Kohinoor Mining Co., G.M.Ls. 22B, 233B, 290B, etc.	..	..	..	762·00	1,709·87	2·24
	Total	..	..	..	**1,093·25**	**2,836·01**	**2·59**

* Dollied and specimens.

Kohinoor North, G.M.L. 330B.

A good-sized but somewhat irregular quartz reef runs through this lease, on a bearing slightly west of north and south of east, dipping at a flat angle to the east. This reef has been opened up to a depth of 100 feet and for a length of about 200 feet; it is of hard white quartz and averages from two to three feet in thickness, but is very irregular, merely being a thread in some places, and in others bulging out to as much as six feet.

Very little stoping has been done and most of the development work was carried out by a company holding an option over the property; this option was thrown up, and at the present time little or nothing is being done on the reef.

Taken right through the stone is said to be very low grade, but occasionally small patches of richer ore occur, these, however, are very small and very irregular.

Near the surface the reef is entirely in greenstone country but in the lower levels it is partly in granite, this being part of the Bull Oak area which is dipping in this direction (*i.e.* westerly).

A yield of 13·38 ozs. of gold was obtained from the crushing of 78 tons of ore from this lease in 1907, being at the rate of ·17 ozs. per ton.

Dreamland, G.M L. 381B.

On this lease a good deal of work has been done above water level on a small quartz leader running north and south, and dipping very flat to the east. This leader is running at right angles to a large ironstone bar which crosses it at its southern end; it is only a few inches in thickness and apparently of no great length. Some very good stone is said to have been taken out of it.

A crushing of 43·50 tons in 1907 yielded 244·37 ozs. of gold, which was at the rate of 5·62 ozs. to the ton.

Squib, G.M.L. 121B.

A fairly rich quartz leader, which runs north-west and south-east and dips to the east, has been worked on this lease, a good deal having been done on it above water level. The vein is in soft decomposed greenstone, and is only a few inches in thickness.

Table showing the Yield of the Squib Lease.

Year.	Name and Number of Lease.	Ore crushed.	Gold therefrom.	Rate per ton.
		Tons.	Ozs.	Ozs.
1905	Squib, G.M L. 121B ...	74·00	68·90	·93
1906	Do.	50·25	35·62	·71
1907	Do.	274·00	422·27	1·61
	Total	**398·25**	**526·79**	**1·32**

Abundance and Late Seddon, G.M.L. 49B, 286B.

The same reef is being worked on both these properties, and a good deal has been done on it above water level (114 feet).

The reef runs about north and south, and dips at a flat angle to the east; it is of hard white quartz, and very lenticular; near the surface it is very small, but it gets larger in depth and along the 100 feet level is up to three feet in width in places. The reef has been proved for a length of over five chains, but is not very well-defined, the quartz occurring in irregular bunches or lenses, the larger makes being said to be very poor.

The shoots of gold are small and irregular, and the stone has to be to a certain extent picked, as a large portion of it is too poor to crush.

The country is soft decomposed greenstone, and the water level is about 114 feet, the supply being fresh.

Table showing the Yield of the Abundance and Late Seddon Leases.

Year.	Name and Number of Lease.	Ore crushed.	Gold therefrom.	Rate per ton.	Total.		Average rate per ton.
					Ore crushed.	Gold therefrom.	
		Tons.	Ozs.	Ozs.	Tons.	Ozs.	Ozs.
1905 ..	Abundance, G.M.L. 49B	157·25	134·34	·85	352·75	249·44	·70
1906 ..	Do.	54·00	34·23	·63			
1907 ..	Do.	141·50	80·37	·57			
1906 ..	Late Seddon, G.M.L. 286B	58·00	38·45	·66	122·50	102·03	·83
1907 ..	Do.	64·50	63·58	·98			
1904 ..	Fingall, G.M.L. 19B ..	12·00	14·02	1·17	49·25	34·98	·71
1905 ..	Do.	37·25	20·96	·56			
1904 ..	Fingall and Abundance G.M.Ls, 19B, 49B	..	..	..	40·75	29·64	·73
	Total	..	..	..	**565·25**	**416·09**	**·73**

Worker, G.M.L. 378B.

The main vein worked on this lease occurs within a small area of granite as shown on the map; it runs slightly west of north and east of south, and dips to the east at an angle of about 25 degrees. It has been worked to water level (120 feet) and for a length of 300 feet, the greater part of this block having been stoped out.

The vein is of clean solid quartz, and is from six to eight inches in thickness, and very regular.

The country is a much decomposed and kaolinised granite, and is very soft, and stands well, thus enabling a small vein to be worked with satisfactory results.

The gold is stated to be very regular right along the vein which appears to have cut out at the south end, but is still going strongly north.

At the north end of the lease are a couple of small quartz reefs, about a chain apart, running north-west and south-east, and dipping flat to the east; the more westerly of these is along the junction of the granite and the greenstone, while the other is entirely in the greenstone. These reefs only outcrop over a length of a couple of chains, and appear to be very lenticular. They are said to be low grade, and no work of any importance has been done on them.

A good supply of fresh water was struck in the main workings in this lease at a depth of about 120 feet.

Table showing the Yield of the Worker Lease.

Year.	Name and Number of Lease.	Ore crushed.	Gold therefrom.	Rate per ton.	Total.		Average rate per ton.
					Ore crushed.	Gold therefrom.	
		Tons.	Ozs.	Ozs.	Tons.	Ozs.	Ozs.
1904 ..	Welcome, G.M.L. 47B ..	78·25	102·97	1·31			
1906 ..	Do.	104·25	105·94	1·02	182·50	208·91	1·14
1904 ..	Worker, G.M.L. 18B ..	24·25	31·43	1·30			
1905 ..	Do.	228·25	263·14	1·11			
1906 ..	Do.	194·75	212·36	1·09	447·25	496·93	1·12
1907 ..	Worker Leases, G.M.Ls. 18B, 47B	..	..	..	157·00	116·38	·74
1907 ..	Worker, G.M.L. 378B (18B, 47B)	..	..	..	348·00	505·81	1·45
	Total	..	..	..	**1.134·75**	**1,328·03**	**1·17**

Chicago, G.M.L. 13B.

The reef on this property was one of the first prospected in the district, but it has only been worked at irregular intervals since then. No work was being done on it at the time of my visit, and the workings were inaccessible.

There are two shafts on the lease apparently to a depth of about 100 feet. The reef is of hard solid quartz, and is from two to four feet in thickness; it appears to be fairly regular in size and can be followed on the surface for about ten chains. It runs about north and south, and dips at a pretty flat angle to the east; on the north it ends abruptly against a large east and west "ironstone bar," and no sign of it has been found north of this.

The stone is stated to be on the whole very low grade with occasional good patches in it.

Table showing the Yield of the Chicago Lease.

Year.	Name and Number of Lease.	Ore crushed.	Gold therefrom.	Rate per ton.
		Tons.	Ozs.	Ozs.
1903	Chicago, G.M.L. 13B (690)	·50	·85	1·70
1904	Do.	22·50	8·96	·40
	Total	**23·00**	**9·81**	**·43**

Table showing the Yield from Leases at Nungarra (and Hancocks), other than those already mentioned, up to 31st December, 1907.

Name and Number of Lease.	Ore crushed.	Gold therefrom.	Rate per ton.
	Tons.	Ozs.	Ozs.
Albion, G.M.L. 450B	5·50	51·74	9·40
Bright Beauty, G.M.L. 38B ...	21·75	23·54	1·08
Bullion, G.M.L. 468B	17·00	5·61	·33
Catherine L., G.M.L. 50B ...	17·00	1·83	·11
Diver, G.M.L. 432B	30·00	22·12	·74
Dream, G.M.L. 56B	55·25	278·46	5·00
Eclipse, G.M.L. 58B	96·75	57·18	·59
Eureka, G.M.L. 36B (742) ...	46·00	76·75	1·67
Evangeline, G.M.L. 157B... ...	17·00	11·14	·65
Geraldtonia, 2B (640)	42·00	125·09	2·98
Golden Acre, G.M.L. 55B ...	337·50	*161·76	...
Golden Acre, G.M.L. 263B ..	27·75	22·35	·80
Golden Ball Extended, G.M.L. 364B	38·00	44·00	1·16
Good Hope, G.M.L. 102B ...	28·50	21·59	·76
Hatter, G.M.L. 186B	24·50	95·86	3·50
Hill End, G.M.L. 142B	14·75	6·26	·36
Jewel, G.M.L. 103B	3·50	·85	·24
Lady Jackson, G.M.L. 51B ...	46·75	18·53	·40
Little Nell, G.M.L. 126B... ...	49·00	15·85	·32
Lord William, G.M.L. 80B ...	27·00	11·19	·41
Missing Link, G.M.L. 285B ...	239·50	382·57	1·60
Mulgarrie, G.M.L. 29B	24·75	3·45	·14
Muriel Chapman, G.M.L. 46B ..	104·00	51·47	·49
Phœnix, G.M.L. 218B	80·50	15·64	·19
Poseidon, G.M.L. 397B	30·00	119·31	3·98
Queen of the Range, G.M.L. 35B (741)	194·00	67·05	·34
Tekoa, G.M.L. 166B	14·50	15·41	1·06
Wanganui, G.M.L. 64B	...	†10·95	...
Welcome, G.M.L. 395B	31·00	6·57	·21
Sundry Claims	1,348·65	‡1,950·30	...

*Includes 25·94 ozs. of alluvial. †Dollied and specimens. ‡Includes 46.07 ozs. alluvial, and 627·02 ozs. dollied and specimens.

Table showing the Yield from Leases at Sandstone, other than tho already mentioned, up to 31st December, 1907.

Name and Number of Lease.	Ore crushed.	Gold therefrom.	Rate per ton.
	Tons.	Ozs.	Ozs.
Aruncourt, G.M.L. 298B... ...	43 00	71·30	1·6
Ballarat, G.M.L 44B	7·75	9·14	1·1
Bilbie, G.M.L. 687	46·97	245·67	5·23
Cardigan, G.M.L. 95B	188·16	199·36	1·06
Dulgite, G.M.L. 24B	250·00	328·89	1·31
Eileen, G.M.L 325B	41·00	13·59	·33
Erinjerry, G.M.L. 215B	14·50	5·37	·37
Floater, G.M.L. 83B	112·50	262·19	2·33
Floater, G.M.L. 233B	51·25	36·14	·70
Great Surprise, G.M.L. 391B ...	...	*5 68	...
Horseshoe, G.M.L. 45B	202·75	238·85	1·18
Jumble, G.M.L. 14B	94·50	86·45	·91
Just in Time, G.M.L. 12B ...	42·50	34·59	·81
Karridale, G.M.L. 194B	27·25	10·95	·40
Lady Maude, G.M.L. 293B ...	23 00	15·67	·68
Redmond, G.M.L. 217B	34·75	18·61	·53
Reindeer, G.M.L. 101B	58·00	68·68	1·18
Reindeer, G.M.L. 195B	26·25	12·92	·49
Wanderie No. 2 East, G.M.L. 72B	7·50	·48	·06
Wild Dog, G.M.L. 111B	8·00	5·34	·67
Sundry Claims	177·50	106·34	·60

*Dollied and specimens.

BELLCHAMBERS.

The centre known as Bellchambers is situated about ten miles south-west from Nungarra townsite, and is on the western edge of the greenstone belt. The country here is fairly hilly, and the rocks on the surface have a much less weathered appearance than is the case at Black Range; they consist of fairly fine-grained greenstones, slightly crushed and foliated, especially near the granite, where a strong schistosity is set up in them parallel to the junction of the two classes of country. A few small granitic dykes run through the greenstones, these being merely offshoots from the main body farther westward.

A small group of leases has been pegged out, but no work of any importance is being done at the present time. The leases are situated about three miles south-south-east from the Range View Hotel, which is ten miles from Nungarra along the Mt. Magnet road.

At the present time the nearest crushing plant is the Black ange State Battery, twelve to thirteen miles distant, and all ne crushed has to be carted there, which considerably adds to expense.

In addition to the main group of leases one or two other nows have been prospected, but without very satisfactory results.

About a mile or so east of the Range View Hotel a little ork has been done on a large copper-bearing quartz reef; this s in schistose greenstone country and runs about north and outh; it outcrops for six or eight chains, and appears to average from two to four feet in thickness. The reef is of hard white uartz and carries occasional small pockets of carbonate copper re.

One or two pot holes have been put down on these ore patches but results were not satisfactory, the ore being poor and only in very small quantity. The amount of ore present in the surface stone is not sufficient to render it of any value at the present time, and there does not appear to be any likelihood of its improving in depth.

Royal Flush, G.M.L. 329B.

This lease is situated about two and a half miles south-south-east from the Range View Hotel. Very little work has been done on it, the deepest workings being about 50 or 60 feet. The surface is mostly covered with recent deposits and debris, and no defined outcrops are visible.

A fair-sized fairly continuous belt of schist runs north-north-easterly through the lease, dipping steeply to the east; small irregular veins and lenses of quartz occur in this belt and a little work has been done on one or two of these; so far work has not exposed anything defined in the way of an ore body, values being very erratic and confined to the quartz bodies which are equally erratic. The schist itself does not carry an appreciable amount of gold.

From this lease in 1907, 153·50 tons were crushed which yielded 210·85 ozs of gold, or an average of 1·37 ozs. to the ton.

Range View Leases, G.M.Ls. 265B, 268B.

These leases are situated about a mile north-east of the preceding one. Not very much work has been done on them, and at the time of my visit they were idle.

A well-defined belt of schist half a chain or so in width runs about north-west and south-east through the leases, dipping steeply to the north-east. Cutting slightly across this are numerous small veins of quartz, some of which carry very good values. The whole of the schist is said to carry a little gold, but apparently most of the work has been on the quartz veins.

MANINGA MARLEY.

This centre is situated 15 miles in a direct line from Nungarra on a bearing about east-south-east. The distance by road, however, is about 18 miles. The country between the two places is mostly flat, and covered with a considerable thickness of recent deposits, the underlying rocks being greenstone.

Maninga Marley is situated in the extreme south-east corner of the Black Range auriferous area, as shown on the accompanying map, the granite being only a mile or so distant both south and east.

The general aspect of the country here is flat, but there are one or two low ridges over which the rocks outcrop. These are massive and slightly foliated greenstones similar to those at Nungarra and Sandstone. They are not so decomposed and weathered, however, and become fairly hard and settled at a depth of about 150 feet.

There is an abundance of fresh water in the district, but timber is fairly scarce.

At the time of my visit only two mines of any importance were working, viz., the Havilah and the Maninga Marley. Both these properties are equipped with 10-head batteries, and the Maninga Marley crushes for the public.

There were one or two other shows being prospected in the neighbourhood, but no work of any importance was being done on them.

Maninga Marley Leases, G.M.Ls. 53B, 77B, 100B.

The reef on this property strikes about 10 degrees north of west and dips steeply to the north. The quartz is not continuous throughout the workings, but occurs in a series of lenses varying considerably in length and thickness. In the present workings three of these lenses have been opened up. The middle and largest one is said to have been about 80 feet in length at its longest part, the 100 feet level, and to have had a maximum width of about six feet. The other two lenses are said to have each been about 30 feet in length, and to have reached about three feet in maximum thickness. The average thickness of the quartz right through the stopes is said to have been about two and a half feet.

These quartz lenses all pitch to the eastward at an angle of about 45 degrees, and are not continuous in depth. Along the 200 feet level there was at the time of my visit about 35 feet of quartz two to three feet wide which was said to be the downward continuation of the main or middle lens, the other two having cut out before this level was reached. Along the 100 feet level the distance between these three lenses was small, but both westward and eastward beyond them for a considerable distance no stone has been encountered. The 200 feet level is about 300 feet in length, and, as above stated, only about 35 feet of this near the middle is in stone. The values along this bottom make of stone are stated to be much lower than along the 100 feet level.

The lenses occur along a well-defined fissure, and have on the footwall side a band of highly-altered greenstone schist, the exact width of which has not been proved. The hanging wall is formed of massive to slightly-foliated greenstone, which in the bottom level is very hard and compact. This wall is irregular and not well defined, but the footwall right through is very clean and regular. The pinches in the quartz are due to irregularities in the hanging wall.

Along the bottom level the line of the lenses is marked by a seam of calcite half an inch or so in width. This runs in a very true line, and extends the full length of the drive.

It appears that the more likely way of finding new ore bodies on this property is by driving rather than sinking and preferably along, say the 100 feet level, where the country is still soft.

The footwall belt of schist can be followed on the surface for some distance through this and the adjoining properties, and occasionally has small makes of quartz associated with it. These as far as tried have not proved of any great value.

The water supply from the mine workings is fresh, and is said to be only just sufficient for present requirements.

Table showing the Yield of the Maninga Marley Leases.

Year.	Name and Number of Lease.	Ore crushed.	Gold therefrom	Rate per ton.	Total.		Average rate per ton.
					Ore crushed.	Gold therefrom	
		Tons.	Ozs.	Ozs.	Tons.	Ozs.	Ozs.
1904 ..	Maninga Marley, G.M.L. 53B	80·25	115·98	1·44	222·75	274·92	1·23
1905 .	Do.	142·50	158·94	1·11			
1906 ..	Maninga Marley Leases, G.M.Ls. 53B, 77B, 100B	1,694·83	1,768·82	1·04	5,271·83	5,629·79	1·07
1907 ..	Do. . ..	3,577·00	3,860·97	1·08			
	Total	.	..	..	5,494·58	5,904·71	1·08

Daphne, G.M.L. 803B.

On this lease, situated about thirty chains farther east, a little work has been done on a small lens of quartz, which is probably on the continuation of the Marley line. This has been sunk on to a depth of 90 odd feet, and driven along for about 20 feet. It is from two to two and a-half feet in thickness, but its gold contents are said to be very low.

Other makes of stone probably occur between this and the Marley, but as most of the surface is covered with recent deposits their outcrops are not visible, and no effort has been made so far to try to locate them below the surface.

Havilah Leases, G.M.L. 203B, 243B, etc.

On this property there appear to be two quartz reefs each striking about east and west, and one dipping to the north and the other to the south.

Only one of these outcrops, viz., the one dipping north, the other running into it about 20 feet from the surface. Prospecting was originally carried out on the outcropping reef, and at a depth of about 20 feet the southerly reef was met with, and as the values were fairly high the work was continued on it.

This vein is very flat, being almost horizontal in places, and has been pretty well worked out in the Havilah Company's ground, but is still being worked on the adjoining property, the Maninga Marley North. It does not appear to have a very long life before it here however.

In thickness this vein varied considerably, but is said to have an average width of about 18 inches. It is ill-defined, and has no regular walls. When it comes in contact with the main, or northerly, reef it appears to turn over and run with it, the shoot of good stone at the same time pitching away pretty flat to the westward. The system of fissuring is, however, very broken, and the quartz bodies very irregular, so that it is very difficult to say exactly what the relationship of the two veins is, but it appears to me that they are two separate fissures and not a saddle reef, as is the local belief.

The present main workings are on the northerly reef, and are down to a vertical depth of 210 feet. A reference to the plan herewith will show the amount of work done up to October last. In these workings the stone has been very erratic in parts, but on the whole is said to have averaged from 18 inches to two feet in thickness.

The country in the deeper workings is very hard, except just along the line of the reef where it is fairly soft, and consists of a ›mewhat crushed and foliated greenstone.

BULLETIN Nº 31 PART 2 PLATE III

PLAN OF

THE HAVILAH G.M.L. 203^{B}

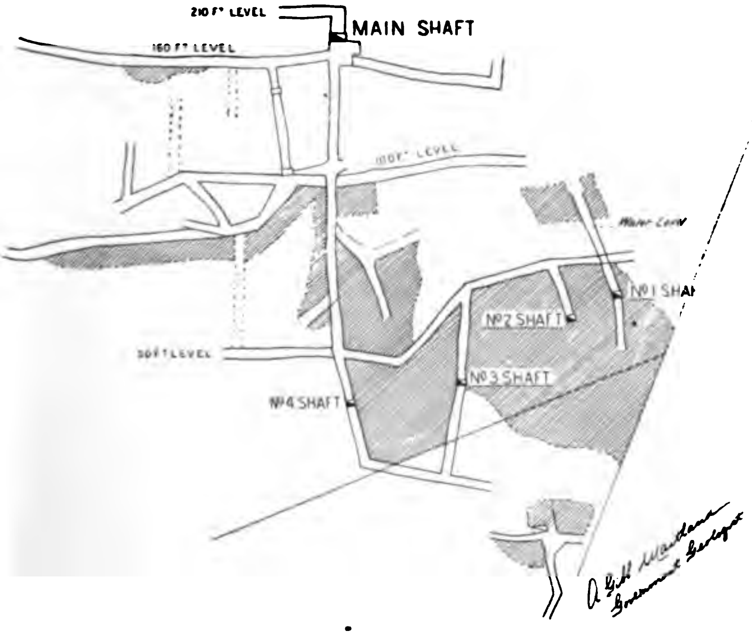
MANINGA MARLEY

EAST MURCHISON G.F.

0 100 200 300

Scale of Feet

Stoped ▨



A Gibb Maitland
Government Geologist

APPROXIMATE ONLY

C B Kidson del

In the deeper workings close to the main shaft the values in the reef are very low, the payable shoot dipping away fairly flat to the west. Along the bottom level there is said to be a blank of over 100 feet before the shoot is reached, and even within it the values are not at all consistent.

The water supply is fresh, and although not too plentiful, is sufficient for all present requirements.

Table showing the Yield of the Havilah Leases.

Year.	Name and Number of Lease.	Ore crushed.	Gold therefrom	Rate per ton.	Total. Ore crushed.	Total. Gold therefrom	Average rate per ton.
		Tons.	Ozs.	Ozs.	Tons.	Ozs.	Ozs.
1905 ..	Havilah, G.M.L. 203B ..	27·75	42·33	1·52			
1906 ..	Do.	290·75	1,028·67	3·43			
1907 ..	Do.	1,180·00	1,244·74	1·05			
					1,507·50	2,315·74	1·54
1907 ..	Havilah Leases, G.M. Ls. 203B, 243B, 249B, &c.	..	..	..	2,240·00	2,432·48	1·08
1907 ..	Havilah G.M. Co., N.L., G.M.Ls. 203B, 243B, 249B, &c.	..	..	..	3,680·00	3,315·87	·90
	Total	..	..	..	**7,427·50**	**8,064·09**	**1·08**

Table showing the Yield of the Maninga Marley North Lease.

Year.	Name and Number of Lease.	Ore crushed.	Gold therefrom.	Rate per ton.
		Tons.	Ozs.	Ozs.
1906	Maninga Marley North, G.M.L. 67B	114·00	436·25	3·83
1907	Do.	738·50	1,066·93	1·44
	Total	**852·50**	**1,503·18**	**1·76**

Some five miles to the north-west of Maninga Marley a little prospecting has been done, but so far nothing of any importance has been discovered.

The country here consists of low greenstone ridges traversed by numerous good-sized "ironstone bars," these trending as a rule about north-east and south-west. Quartz reefs are plentiful, but they are mostly small and of no length, the country being too broken and the "bars" too numerous to permit of reefs of any great length occurring, especially as the prevailing strike of the reefs is almost at right angles to that of the "bars."

Several large-sized quartz blows occur associated with these "bars," but they appear to be of no value.

Nearly all the work that has been done in the locality has been on small quartz leaders, and these have so far not proved of any sensational value.

I see no reason why payable reefs similar to those worked at "Hancock's" should not be found here, but I do not think anything of a very large or very permanent nature is likely to be met with.

Table showing the Yield from Leases at Maninga Marley, other than those already mentioned, up to 31st December, 1907.

Name and Number of Lease.	Ore crushed.	Gold therefrom.	Rate per ton.
	Tons.	Ozs.	Ozs.
Agnes, G.M.L. 341B	141·00	60·90	·43
Another Shot, G.M L. 69 ...	6·25	7·02	1·12
Crown, G.M.L. 210B	11·00	21·46	1·95
Kurrajong, G.M.L. 335B	62·25	56·10	·90
May King, G.M.L. 148B	22·25	18·23	·82
May King, G.M.L. 267B	81·00	32·12	·40
Sundry Claims	267·00	132·06	·79

BIRRIGRIN.

After leaving Sandstone the road to Birrigrin which lies 38 miles north-north-east, passes over about eight miles of greenstone country. For the first three or four miles this is mostly flat and covered with extensive recent deposits, but beyond this it becomes more hilly, and the rocks outcrop again in a more unweathered state. Hematite quartz lodes are plentiful about here, and mostly run on a bearing between north and north-west. They are of fair size and appear to be fairly persistent. Numerous quartz reefs occur both associated with the hematite lodes and independently, some of them being of considerable size. A little gold is reported as having been obtained here, and there is no reason why payable reefs should not be found.

After leaving the greenstones the road passes on to granite country just before reaching the "18-mile" well, nine miles from Sandstone. This continues unbrokenly to a point about 14 miles from Birrigrin, where another belt of greenstone makes its appearance. This granite area is flat and covered with a considerable thickness of loose sandy soil. The only rock outcrop is at Walkenjerrie, where there is a large weathered granite "breakaway;" both easterly and westerly this granite country pears to open out into very extensive areas.

The greenstone belt entered on at a point 14 miles from Birrigrin has a width of eight or nine miles, and extends north and south for some distance, its exact limits in this direction being unknown. It is hilly, and the rocks are mostly slightly foliated greenstones traversed by a few good-sized hematite quartz lodes. The country is similar to that lying just north of Sandstone, and as it appears to be of considerable extent it should be well worthy of attention. Beyond this belt again is another patch of granite, which extends right to Birrigrin where more greenstone makes its appearance, the majority of the leases here being close to the junction of the two classes of country.

This belt of greenstone in which the Birrigrin leases are situated is probably of considerable extent, but the greater part of it is covered by recent deposits to such an extent as to render it almost useless for prospecting purposes. It includes the centres of Montague and Prominent Hills, but its extension beyond these is not known nor are its north and south extensions.

At Birrigrin are a few low ridges extending only a few miles in length and a mile or so in width. Over this area the greenstones outcrop, and it is within it that the mining leases are situated.

These greenstones are slightly foliated, and are traversed by a number of small granitic dykes, these being apparently offshoots from the main body farther west. Just along their junction with the main granite mass the greenstones are much crushed and foliated, the lines of foliation being parallel to the junction, but this only extends over a width of a few chains.

The whole of the granite area is covered with a considerable thickness of loose sandy soil, the only outcrops being just along the junction and a mile or so south-east from the townsite where there are a few low hills.

The greenstones are mostly covered with ironstone and quartz rubble, which hide a great portion of the surface detail.

There is a fair-sized deposit of laterite about half a mile or so north of the townsite, forming the capping of a low ridge.

The granitic dykes as a rule run roughly parallel to the edge of the main body, *i.e*, about north-west and south-east. They are generally small, and as a rule not very continuous in length. They are most numerous towards the south end of the leases, and are found chiefly within a distance of 20 chains from the main body. They appear to be of earlier origin than the quartz reefs, which fact adds to the belief that they are merely off-shoots from the main mass and not a later intrusion.

Quartz reefs are fairly numerous, but are in no cases large or of any great length, and they are as a rule of marked lenticular habit. They are frequently found along the junction of the granite and greenstone and alongside the granite dykes in the greenstones, being in these cases very irregular and without much chance of permanency.

The general trend of all the reefs worked is between north-west and north, and their dip is as a rule almost vertical. So far most of them have been at no great distance from the granite, as can be seen by reference to the plan herewith.

No great amount of work has been done on any of these reefs, and only two or three of them have been worked below water level. At the present time mining operations are very quiet, and very little stone is being raised, the principal properties being under exemption.

Water is plentiful throughout the district, and is invariably fresh. It is usually met with at a depth of from 50 to 60 feet.

Timber is fairly plentiful at present, but the supply is limited, and consists almost entirely of mulga. A little gum timber is procurable towards Lake Mason, eight to ten miles south, but this is being rapidly cut out, chiefly for the requirements of the Sandstone mines.

There is a subsidised five-head battery at Birrigrin which crushes for the public.

The following is a brief description of such of the mines in the district as were working at the time of my visit:—

Hawthorn (Birrigrin Gold Mines), G.M.L. 109B.

Two lines of reef have been opened up on this property, which are roughly parallel and run on a bearing a little north of north-west. Their dip is practically vertical.

They are both lenticular quartz reefs, and vary considerably in size, especially the east reef. This has been opened up to a depth of 140 feet and for a length of about 250 feet. Its average thickness throughout is probably nearly three feet, but it appears to be increasing in size, in depth being nearly five feet along the bottom level. For part of its length this reef is alongside a granitic dyke and is here specially irregular, cutting out altogether for some distance. The quartz is hard, white, and glassy, and carries a small percentage of copper. It is stated to be pretty low grade taking it right through.

The west reef has been worked to a depth of 160 feet and opened up for a total length of 150 feet, There is only one lens of stone in these workings, and this has a total length of about 120 feet, having cut out in both ends of the workings. The average thickness of this body of stone is about two feet, and it does not appear to be improving in depth. The stone is similar in appearance to that in the east reef, but is stated to carry much better values. Like the east reef this one is also for part of its length alongside a granitic dyke and is very irregular.

The country consists of foliated greenstone, very soft and rotten near the surface, but getting hard and settled in the bottom workings.

Table showing the Yield of the Hawthorn Leases.

Year.	Name and Number of Lease.	Ore crushed.	Gold therefrom	Rate per ton.	Total.		Average rate per ton.
					Ore crushed.	Gold therefrom	
		Tons.	Ozs.	Ozs.	Tons.	Ozs.	Ozs.
1905 ..	Hawthorn, G.M.L. 109B	354·50	439·06	1·24			
1906 .	Do.	876·00	1,073·83	1·22			
1907 .	Do.	324·50	500·36	1·54			
1905 .	Ione, G.M.L. 130B ..	— —	— —	— —	1,555·00	2,013·25	1·29
		..	.	.	24·00	20·83	·87
	Total	..	..	..	**1,579·00**	**2,034·08**	**1·28**

Stranger, G.M.L. 113B.

A little work was being done on this lease on a small body of quartz, which is apparently a continuation of the east reef on the Hawthorn, and is said to be of no great value.

Table showing the Yield of the Stranger Lease.

Year.	Name and Number of Lease.	Ore crushed.	Gold therefrom.	Rate per ton.
		Tons.	Ozs.	Ozs.
1905	Stranger, G.M.L. 113B ...	38·50	36·93	·96
1906	Do.	319·00	387·83	1·21
1907	Do.	18·50	26·59	1·44
	Total	**376·00**	**451·85**	**1·20**

Pelerin, G.M.L. 128B.

The reef here worked runs about north and south, and has an almost vertical dip, the actual underlie being 2 feet in 100 feet to the west. It has been worked to a depth of 135 feet and for a total length of over 200 feet, most of the work having been done at and above the 85 feet level. The reef is of solid quartz from 18 inches to two feet in average thickness, its greatest width being about three feet. It carries a small percentage of copper. At the south end of the workings at the 135 feet level it is very small and broken, being here in contact with a fair-sized granite dyke. The shoot of gold is stated to be about 200 feet in length, and over this distance the values are said to be very good, especially down to the 85 feet level ; below this they get somewhat poorer.

Except where it comes in contact with the granite dyke the reef is in slightly-foliated greenstone, which is very hard in the bottom workings.

There is a good supply of fresh water in the workings, its level being about 65 feet.

About four chains north of the main workings a little work has been done on the same reef above water level. The stone is stated to be smaller here and of rather low value.

Table showing the Yield of the Pelerin Lease.

Year.	Name and Number of Lease.	Ore crushed.	Gold therefrom.	Rate per ton.
		Tons.	Ozs.	Ozs.
1905	Pelerin, G.M.L. 128B ..	226 00	635·92	2·83
1906	Do.	549·00	1,666·57	3·03
1907	Do.	239·75	384·60	1·60
	Total	**1,014·75**	**2,687·09**	**2·65**

Reply, G.M.L. 133B (Battery Lease).

The workings on this lease were not accessible at the time of my visit, owing to the water being up. The reef runs about north-west and south-east, and is along the eastern side of a granite dyke. It is stated to be as much as three feet in width in places, but very irregular and of very little value. Where seen near the surface the stone was about two feet in average thickness and very broken.

There is a plentiful supply of fresh water at a depth of about 50 feet.

The five-head subsidised battery is situated on this lease, and draws its water supply from the old workings.

Table showing the Yield of the Reply Lease.

Year.	Name and Number of Lease.	Ore crushed.	Gold therefrom.	Rate per ton.
		Tons.	Ozs.	Ozs.
1905	Reply, G.M.L. 133B	55·50	21·95	·39
1906	Do.	23·50	12·89	·54
1907	Do.	56·50	12·58	·22
	Total	**135·50**	**47·42**	**·35**

Belfast, G.M.L. 163B.

Two small parallel quartz leaders have been worked on this lease, one to water level (50 feet) and the other to about 40 feet. These are merely two short lenses of quartz in slightly laminated greenstone, and are of small size and will probably not live to any great depth. They run about north and south and have a practically vertical dip.

The more easterly vein, which has had the more work done on it, is from six to twelve inches in average thickness, being stated to be slightly larger at water level. The second vein is about six inches in thickness as far as opened up at present. Very little work has been done on either of them.

The country is foliated greenstone, and is fairly hard right to the surface.

Table showing the Yield of the Belfast Leases.

Year.	Name and Number of Lease.	Ore crushed.	Gold therefrom.	Rate per ton.
		Tons.	Ozs.	Ozs.
1906	Belfast, G.M.L. 163B ...	88·00	120·31	1·37
1907	Do.	52·00	64·98	1·24
	Total	**140·00**	**185·29**	**1·32**

Wheal Ellen, G.M.L. 168B.

The main shaft on this lease is down to a depth of about 160 feet, but very little work has been done.

A well defined quartz reef two to three feet in thickness runs through the lease in a north and south direction, dipping about vertically. Where the main workings are situated this reef cuts across and faults a small "ironstone bar" running about north-west and south-east. The displacement in the "bar" is about 15 feet, the part on the western side of the reef being thrown to the north.

This "bar" near the surface is from 12 to 18 inches in thickness, and consists of the usual laminated ironstone and quartz, but below water it turns into a belt of crushed greenstone six to eight inches in width with a seam of solid pyrites half an inch in thickness running along the middle of it.

At the two points where the reef and the "bar" come in contact very rich pockets of stone occurred, most of which was specimen stone. The better of those two pockets was on the east side of the reef, the other one being much smaller and poorer. This main pocket, or shoot, was only a couple of feet in length, and did not extend much below water level, being particularly rich near the surface. The gold is said to have gone only a few inches into the reef, being right on the contact of it with the bar; a few feet away from it the stone is no good at all.

The present owners of the property have sunk a main shaft 160 feet and a crosscut into the reef at this depth. The line of the "bar" has been picked up, and a rise was put up to connect with the old workings. This showed the shoot of gold to have cut out completely, probably just below the water level.

The main reef at this bottom level is a nice body of solid quartz two to three feet in thickness, but unfortunately it carries no values. The line of the "bar" is marked here by a seam of crushed rock six inches or so in width carrying a solid vein of pyrites half an inch in thickness.

The country is slightly foliated greenstone, and gets very hard and tight at about 80 feet.

A little alluvial gold has been obtained in a small gully at the north end of this lease. The gold appears to have been shed from a small leader rather than from the rich shoot worked on the lease.

Table showing the Yield of the Wheal Ellen Lease.

Year.	Name and Number of Lease.	Ore crushed.	Gold therefrom.	Rate per ton.
		Tons.	Ozs.	Ozs.
1905	Wheal Ellen, G.M.L. 168B	39·50	*456·88	11·56
1906	Do.	161·50	†1,753·96	10·86
	Total	**201·00**	**2,210·84**	**11·00**

*Includes 196·43 ozs. dollied and specimens. †Includes 590·00 ozs. dollied and specimens.

In addition to the above leases several small parties were prospecting in the district, but no work of any importance was being done by them.

Table showing the Yield from Leases at Birrigrin, other than those already mentioned, up to 31st December, 1907.

Name and Number of Lease.	Ore crushed.	Gold therefrom.	Rate per ton.
	Tons.	Ozs.	Ozs.
Collendina, G.M.L. 160B... ...	105·50	63·31	·60
Excellent, G.M.L. 394B	17·00	4·93	·29
Golden Spur, G.M.L. 129B ...	352·00	147·01	·42
Grace Darling, G.M.L. 104B ..	109·50	142·39	1·30
Great Aurora, G.M.L. 319B ...	59·50	23·14	·39
Independence, G.M.L. 296B ...	32·50	14·12	·43
Possible, G.M.L 192B	33·00	19·75	·60
Possible, G.M.L. 429B	111·50	173·70	1·56
Red Castle, G.M.L. 159B ...	135·50	316·31	2·33
Sebastopol North, G.M.L 471B ...	4·50	26·33	5·85
Woodleys, G.M.L. 279B	160·20	126·02	·79
Sundry Claims	139·50	83·52	·60

MONTAGUE.

This centre is situated eight to ten miles north of Birrigrin. The only leases on which any work of any importance was being done were the Caledonian and the New Year's Gift. One or two parties were prospecting on the old leases farther north, but no systematic work was being done on any of them.

The country is mostly flat, and the greater part of it is covered to a considerable depth with recent deposits, thus rendering prospecting difficult, as all reef outcrops are hidden. These recent deposits are very extensive between Birrigrin and Montague.

The underlying rocks are greenstone, and the belt is apparently a continuation of the Birrigrin one.

The water level on the low-lying country is very shallow, being only about 30 feet, and the prospectors are considerably handicapped on this account.

At the present time most of the stone raised is brought into Birrigrin to be crushed, as there is only a small Tremaine mill at Montague, and this cannot deal satisfactorily with any but small parcels.

New Year's Gift, G.M.L. 167B.

A small quartz reef has been worked here which strikes about north and south and dips steeply to the west. It has been worked for a length of 60 feet or so near the surface. It is very irregular and appears to have cut out at both ends, being merely a single lens of quartz occurring in slightly laminated greenstone. Its greatest thickness is about two feet, but its average is considerably less than this.

The owners have a vertical shaft down about 90 feet, and are crosscutting to meet the reef at this depth. The chances of a payable body of stone being found appears to me, however, to be very remote.

The country is foliated greenstone, and is very soft and rotten as far as worked.

Water level is about 30 feet, and the supply is fresh.

Table showing the Yield of the New Year's Gift Lease.

Year.	Name and Number of Lease.	Ore crushed.	Gold therefrom.	Rate per ton.
		Tons.	Ozs.	Ozs.
1905	New Year's Gift, G.M.L. 167B	42·50	77·13	1·81
1906	Do.	9·00	6·26	·69
	Total	**51·50**	**83·39**	**1·62**

Caledonian, G.M.L. 185B.

This lease was being worked in a fairly systematic way at the time of my visit, and developments were very promising.

The reef runs north and south, and dips steeply to the west. It has been opened up for a length of 300 feet down to water level, and practically all the stone for this length has been stoped out: it appears to be cutting out at the south end, but is still going strong to the north. The quartz is very broken and irregular down to water, but will probably become better defined at a depth. Its average width is about 2½ feet, but it varies from as much as three feet down to a few inches. It is very rubbly and much ironstained, and below water will probably carry a large percentage of pyrites.

Values are said to be fairly regular over the whole length, and to be slightly better along water level.

The country is very soft weathered greenstone, and the surface is covered with a considerable thickness of recent deposits, so that the outcrop of the reef cannot be followed.

Water level is about 30 feet, and the supply is fresh.

The owners have erected a boiler and pump, and are now sinking a main vertical shaft which they intend carrying down to 120 feet, and then croscutting at the 100 feet to pick up the reef.

Table showing the Yield of the Caledonian Lease.

Year.	Name and Number of Lease.	Ore crushed.	Gold therefrom.	Rate per ton.
		Tons.	Ozs.	Ozs.
1905	Caledonian, G.M.L. 185B	65·90	51·35	·78
1906	Do.	203·00	523·70	2·58
1907	Do.	78·00	210·15	2·69
	Total	**346·90**	**785·20**	**2·26**

Several other properties have been worked a mile or so north of the Caledonian, but these were idle at the time of my visit. They have been described by the State Mining Engineer, who saw most of them when they were being worked, in a report published in the Annual Report of the Department of Mines for the year 1906.

Table showing the Yield from Leases at Montague, other than those already mentioned, up to 31st December, 1907.

Name and Number of Lease.	Ore crushed.	Gold therefrom.	Rate per ton.
	Tons.	Ozs.	Ozs.
K's and J's Reward, G.M.L. 436B	9·00	40·55	4·50
Mayflower, G.M.L. 181B	26·00	19 16	·71
Montagu, G.M.L. 136B	29·25	18·86	·64
Montagu Boulder, G.M.L. 135B ...	240·00	121·92	·51
Montagu Main Reef, G.M.L. 143B	33·00	14·61	·44
Montagu Main Reef, G.M.L. 403B	7·00	2·12	·30
Montagu Monarch, G.M.L 175B...	159·50	431·63	2·70
Our Jack, G.M.L. 448B	10·00	9·80	·98
W.G.M., G.M.L. 376B	4·00	5·91	1·48
Rossie Castle, G.M.L. 180B ...	34·00	26·01	·76
Yale Lock, G.M.L. 201B	101·00	29·76	·29
Sundry Claims	59·25	23·37	·31

worked for a length of 60 feet or so near the surface. It is very irregular and appears to have cut out at both ends, being merely a single lens of quartz occurring in slightly laminated greenstone. Its greatest thickness is about two feet, but its average is considerably less than this.

The owners have a vertical shaft down about 90 feet, and are crosscutting to meet the reef at this depth. The chances of a payable body of stone being found appears to me, however, to be very remote.

The country is foliated greenstone, and is very soft and rotten as far as worked.

Water level is about 30 feet, and the supply is fresh.

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The reef runs north and south, and dips steeply to the west. It has been opened up for a length of 300 feet down to water level, and practically all the stone for this length has been stoped out; it appears to be cutting out at the south end, but is still going strong to the north. The quartz is very broken and irregular down to water, but will probably become better defined at a depth. Its average width is about 2½ feet, but it varies from as much as three feet down to a few inches. It is very rubbly and much ironstained, and below water will probably carry a large percentage of pyrites.

Values are said to be fairly regular over the whole length, and to be slightly better along water level.

The country is very soft weathered greenstone, and the surface is covered with a considerable thickness of recent deposits, so that the outcrop of the reef cannot be followed.

Water level is about 30 feet, and the supply is fresh.

The owners have erected a boiler and pump, and are now sinking a main vertical shaft which they intend carrying down to 120 feet, and then crosscutting at the 100 feet to pick up the reef.

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Montagu, G.M.L. 136B	29·25	18·86	·64
Montagu Boulder, G.M.L. 135B ...	240·00	121·92	·51
Montagu Main Reef, G.M.L. 143B	33·00	14·61	·44
Montagu Main Reef, G.M.L. 403B	7·00	2·12	·30
Montagu Monarch, G.M.L. 175B...	159·50	431·63	2·70
Our Jack, G.M.L. 448B	10·00	9·80	·98
W.G.M., G.M.L. 376B	4·00	5·91	1·48
Rossie Castle, G.M.L. 180B ...	34·00	26·01	·76
Yale Lock, G.M.L. 201B	101·00	29·76	·29
Sundry Claims	59·25	23·37	·31

Sundry Returns from the Black Range District generally.

	Ore crushed.	Gold therefrom.
	Tons.	Ozs.
Sundry parcels treated at the Earlsville Mill...	...	cy. 54·71
Do. ElDorado Custom Mill ...	...	cy. 307·87
Do. Maninga Marley Works ...	...	cy. 407·97
Do. Nungarra Metallurgical Works	...	cy. 717·53
Do. Reply Public Battery ..	...	cy. 1,180·04
Do. Nungarra State Battery ...	18·00	*4,392·72
Reported by Banks and Gold Dealers	...	†1,043·73

*Includes 2,853·88 ozs. by cyanide. †Alluvial.

COORANG (YOUANME).

The present mining centre of Coorang is situated some 80 miles in an east south-easterly direction from Mount Magnet, and about 45 miles south south-west from Black Range, being 28 miles south from the Magnet-Range road at its nearest point.

The auriferous belt has its northern limit a few miles north of Trig. station N.B. 47, and runs in a general south to south-easterly direction towards Lake Barlee. Its full extension in this direction is not definitely known, but it does not appear to continue unbroken for more than ten or a dozen miles. Auriferous country is known to occur on the south edge of Lake Barlee, but the belt is apparently distinct from that at Coorang, and is said to be very badly off in the way of surface water (soaks, etc.), for which reason prospecting over it has been considerably handicapped.

The extent of the auriferous country at Coorang is about 10 miles in width by some 20 in length. The rocks comprising it are the usual type of greenstone (amphibolites), and are mostly coarse-grained and massive. Intersecting them are occasional dykes and masses of intrusive granite.

The existence of this belt has been known for a number of years, and a good deal of prospecting was done on it 12 to 13 years ago by Payne and others, who found gold-bearing reefs, but none of any great size or promise. The reef at present being worked by Roberts and party was originally worked years ago by Payne who took out a couple of small crushings. That being now worked by Smitheram and party is also said to have been prospected some 12 years ago by the Gardiners who, rumour says, dollied a pickle bottle full of gold out of it. This statement, however, apparently lacks verification, and the appearance of the reef at the present time certainly does not tend to give credence to the story.

The locality can be reached by road from either Mount Magnet or Black Range. To approach it from the former place, the Black Range road is followed to about the 38-mile peg, at which point the Coorang road branches off south to south-easterly, and passing Crews' homestead goes through the rabbit-proof fence at the Palagea Rock Holes (K. 77), thence south-east to easterly to the new Coorang well. After passing Crews' it is practically a dry stage to Coorang (35 miles), for although there is plenty of water in the tank at the rabbit-proof fence it is at the present time so bad as to be unfit for human consumption, and horses will not look at it unless hard pushed. The tank requires cleaning out in readiness for the next rain. After rain there is also water at the Coffin Hole, 12 miles from Coorang, which, however, would last only a very short time if drawn on to water horses, etc. This road is at the present time in fairly good condition, but it "wobbles" a good deal, and with any heavy traffic would cut up badly. This latter statement, however, would apply to any other road made here.

From Black Range the district is reached by a road going southerly from Bellchambers (10 miles from Black Range). This road is stated to be very heavy, and in addition there is said to be no water between Coorang well and Bellchambers a distance of about 40 miles.

The claims now being worked are situated towards the northern end of the auriferous belt, and are scattered over an area some ten miles by five. There are probably about 50 men on the field.

The line of lode in which most interest is at present being centred is that now being prospected by Millar and party and others. This consists of a belt of crushed greenstone (schist) of varying width lying along the western side of, and caused by, a large intrusive dyke of granite. The surface of the country here is all more or less covered with detrital deposits which hide most of the detail. The schist belt, however, has been picked up at intervals for a considerable distance, following the granite all the way, its general trend being a little west of north. In Millar and party's lease the junction between the greenstones and the granite is very regular, and the schist has a well-defined trend (parallel to the junction). A little farther north, however, numerous arms run out from the larger granite mass across the schists, and there are also smaller parallel dykes lying from a few feet to several chains from the main one, consequently the schists are very much contorted and broken. In one or two places narrow arms of schist a few feet in width lying between two granitic dykes are being prospected under the belief that they are the same "lode" as Millar and party are working. Leases have been pegged out along this belt of schist for a distance of over a mile on the assumption that there is a continuous lode running through them all. This is decidedly not the case, for, although there may be ore bodies in the schist, to call the whole belt in parts probably 10 to 20 chains wide—a continuous "lode" is far from correct.

This schist belt is merely a zone of crushed greenstone such as are almost always found on the West Australian Goldfields alongside areas of intrusive granite. In these schists are numerous small quartz veins and seams generally running parallel to the lines of foliation, they are, however, never of any great size or length. They sometimes carry gold, but so far nothing very rich has been found, the majority of them being very poor.

Millar and party, who are situated about four miles northwest from the new Government well, have two shafts about a chain apart on their lease, one about 30 feet in depth and the other about 40 feet. Both of these are in the schist belt, and are on a portion of it which is seamed with small quartz and ironstone veins, the largest of these being about 10 inches in thickness, while the majority are from one half to one inch. These veins run with the schists, which are here striking about 10 degrees west of north and dipping steeply to the west, and occur over a width of from 6 to 8 feet and possibly more. A sample (370) taken across a six feet face at the bottom (30 feet) of the south shaft gave an assay 4 dwts. 15 grs. of gold per ton. A general sample (369) of the quartz (only) from the dump gave 16 dwts. 21 grs. of gold per ton, while a general sample (372) of the schist (only) from the dump gave absolutely the same result.

In addition to the above a number of samples were dollied on the spot, and these gave mostly results equal to about 10 dwts. per ton.

Several specimens of schist were seen carrying fine gold, this being mostly on the cleavage planes. It would appear though that the bulk of the gold is closely associated with the quartz and ironstone veins. Insufficient work has been done to give any accurate idea of the possible value of this property, but in view of the above results it should be well worth developing further, especially as there is apparently a large body of ore, and though the sample from the bottom of the shaft is certainly low, still it may not be strictly representative of the whole.

South from Millar and party's lease Jones and Coventry have done a little costeening, and in one place have exposed the schists carrying small veins of quartz, as in Millar's lease. A sample (363) taken from this costeen over a six-foot width (of quartz and schist) gave on assay gold at the rate of only 7 grains per ton.

Prospecting is also being carried on farther south, but so far without satisfactory results.

Northward from Millars a number of leases have been pegged and several parties are prospecting. As before stated the schists are much broken here, and so far prospecting has not revealed anything very startling in the way of ore bodies.

The most work at this end has been done by *Duggan and Flynn*, who have a shaft down about 40 feet. These workings are nearly half a mile north of Millars, and the schists here are intersected by numerous granitic dykes, and are much broken. Numerous small quartz leaders outcrop on the surface, but are never of any length. The shaft has been sunk on a belt of schist with small quartz and ironstone leaders, and the similarity between this and Millars "lode" has helped the belief that they are one and the same thing. The deposit is said to be payable over a width of at least three feet, but sampling did not tend to bear out this statement. A number of samples from the dump and also from quartz leaders at the surface were dollied, and though they certainly all contained gold the results were anything but good. Two samples were taken for assay, No. 1 being a general sample from the dump taken by myself, and No. 2 being a sample of the supposed richest stone taken by one of the prospectors. These gave results as follows:—

No. 1 (359) Gold, 7 dwts. 8 grs. per ton.

No. 2 (360) Gold, 12 dwts. 18 grs. per ton.

Northward beyond Flynn's prospecting has not so far yielded very promising results.

Outside this line all the deposits being worked in the district are ordinary quartz reefs mostly small and of no great value, as will be seen from the following descriptions:—

Roberts and party are situated about four miles a little north of west from the new Government well. The lease was originally worked a good many years ago by Payne and party, and some fairly rich stone is said to have been taken out, the returns from which, however, are not available.

Running through the lease in a north and south direction are several small "ironstone bars," which mark old thrust or fault planes, and crossing them in a north-easterly direction is a small quartz reef. At the points of intersection of the reef with the "bars" rich shoots occur, and two of these have been worked down to water level (140 feet). The length of the shoots appears to have been only a few feet, and to be practically all in the shafts, as little or no driving has been done, which would hardly have been the case had the values extended farther. The reef is small and irregular, ranging in thickness from a mere thread to over two feet. If the reef is driven along values will probably be met with, but they are not likely to be equal to those got in the shafts. A sample (366) taken from the reef at the bottom of the south shaft (140 feet) gave on assay 10 dwts. 8 grs. of gold per ton, which looks as if values are not improving at a depth. Recent crushings from this lease totalled 33 tons for 44·58 fine ounces, which is equal to an average of 1·35 ounces per ton.

The workings on this property are on the top of a rise, which accounts for the deep water level.

Rowan and party are situated some four to five miles north-east from the Government well.

The owners of the lease are at present sinking a main vertical shaft for the purpose of obtaining water, and are now down about 120 feet, but being on high ground will probably have to go some distance farther.

A fairly well-defined line of reef is traceable at intervals on the surface for about five chains, but the stone is not continuous, occurring in a series of lenses, the main one of which is nearly two chains in length. This lens of stone was passed through in the main shaft at a depth of about 15 feet, and was here some three feet in thickness and not well defined. The general strike of the reef is slightly east of north, and its dip is steeply to the east. The quartz is hard and glassy, often a good deal iron-stained, and is said to carry a little gold right through. Several samples from the dump and from different points along the outcrop were dollied, but the results were not good. A general sample (361) taken from the dump gave on assay 12 dwts. of gold per ton.

Smith and Henry are working about a mile from Rowans to the eastward. On this block there is a quartz reef striking about N.N.E. and S.S.W. with a vertical dip. The outcrop is fairly regular and well defined, and is traceable for over five chains varying in width from a thread to two feet. A shaft has been put down on it to a depth of about 30 feet. There are two feet of stone at the surface and about 10 inches at the bottom of the shaft, but it is of very low grade. A little gold is said to be procurable right along the outcrop, but the values are nowhere very good. Two samples were taken, No. 1 being from the bottom of the shaft and No. 2 a general sample along the outcrop. These gave on assay the following results :—

No. 1 (364) Gold, 13 grains per ton.

No. 2 (367) Gold, 4 dwts. 15 grs. per ton.

Christensen and party are about a mile south-easterly from Smith and Henry. A couple of small quartz reefs run through this block on a north and south bearing, dipping steeply to the west. The more westerly of these has been sunk on to a depth of 40 feet. Near the surface there is about two feet of stone, but this cuts out at from 20 to 30 feet. In the bottom of the shaft a little stone is coming in, which is probably the commencement of another lens. A little good stone was got near the surface, but the bulk of it is poor. The lenticular habit of the reef is very marked on the surface as well as in the shaft.

No work has been done on the second line beyond a costeen or two, which show the reef to be about a foot in thickness at the points exposed.

Donovan and party are working not far from Christensen's. They have a shaft down about 30 feet, and have done about 20 feet of driving on a small north and south quartz leader, which is only a few inches in thickness at the surface, and at the bottom of the shaft is a mere thread. A general sample (362) taken from the dump gave on assay, 1 dwt. 2 grs. of gold per ton.

Smitheram and party are situated a couple of miles east of the Government well. There is a well marked line of reef on the surface here, which is traceable for over five chains and apparently varies from one to three feet in thickness, occasionally, however, cutting out altogether. Its general trend is about north and south, and the dip is steeply to the west. A shaft has been put down on the reef to a depth of about 40 feet. This started on about three feet of stone, which has pinched to about six inches in the bottom, and is very low grade as well. Several samples from the outcrop of the reef were dollied, but the results showed only a few dwts. of gold per ton. A general sample (365) from the dump gave on assay 12 dwts. of gold per ton.

Moore and party, half a mile or so east of Smitheram's, are working on a small north and south quartz reef which they have sunk on down to water level (80 feet), the water being brackish and unfit for use. This reef, which does not outcrop for any great length is a couple of feet in width at the top of the shaft, but gradually pinches out in depth, and has cut out practically altogether in the bottom. The owners intend driving at water level to try and pick up another lens of stone. There is a second small reef a couple of chains farther east, but no work has been done on it. A little good stone was taken out of the main shaft, but the bulk of it is poor. A general sample (368) from the dump gave on assay 6 dwts. 19 grs. of gold per ton. Twenty chains or so to the south-west is a fair-sized quartz reef carrying small pockets of carbonate copper ore. These, however, are not large or rich enough to be of any use, and are not likely to improve much if sunk on. There is a little gold in the stone, but as far as tried not in payable quantity.

In addition to the above there are one or two other parties prospecting in the district, but they have got nothing of importance so far.

With regard to the water supply of the district, there is a newly-completed Government well in which there is a splendid supply of good water. This well was sunk 95 feet, and a bore hole was put in from the bottom of it for another 20 feet when a strong flow was met which rapidly rose till it reached to about the 75 feet level in the shaft. This supply is likely to prove adequate for all requirements. In addition to the Government well, water is also obtainable from Roberts and party's lease, but the supply is at present limited, as the shaft is only a couple of feet below water level. Further sinking would probably provide a good supply.

A boring party is still in the district, and at the time of my visit was boring on a flat near Rowan's. This bore should have now reached water. A bore was previously put down near Smith and Henry's, and a supply was struck at about 100 feet. This, however, was highly mineralised and not fit for human consumption.

If at any time there should be any heavy traffic to the district, a water supply will be needed on the road, say near the rabbit proof fence. If the tank at the fence were cleaned out and made fit for use it would after the first rain probably be sufficient for all present requirements.

In conclusion, I am of opinion that the district is not likely to be of any great importance. The so-called "lode formation" worked by Millar and others is, I think, not likely to develop into a payable proposition (with the possible exception of the part in Millars lease), and though quartz reefs are fairly numerous, they are mostly on the small side, and exhibit a very strongly marked lenticular habit, and do not appear likely to live to any great depth. They are also, as far as sampled, of low grade, and though one or two richer ones may be found, I think the majority of them would prove unpayable even with a battery close handy.

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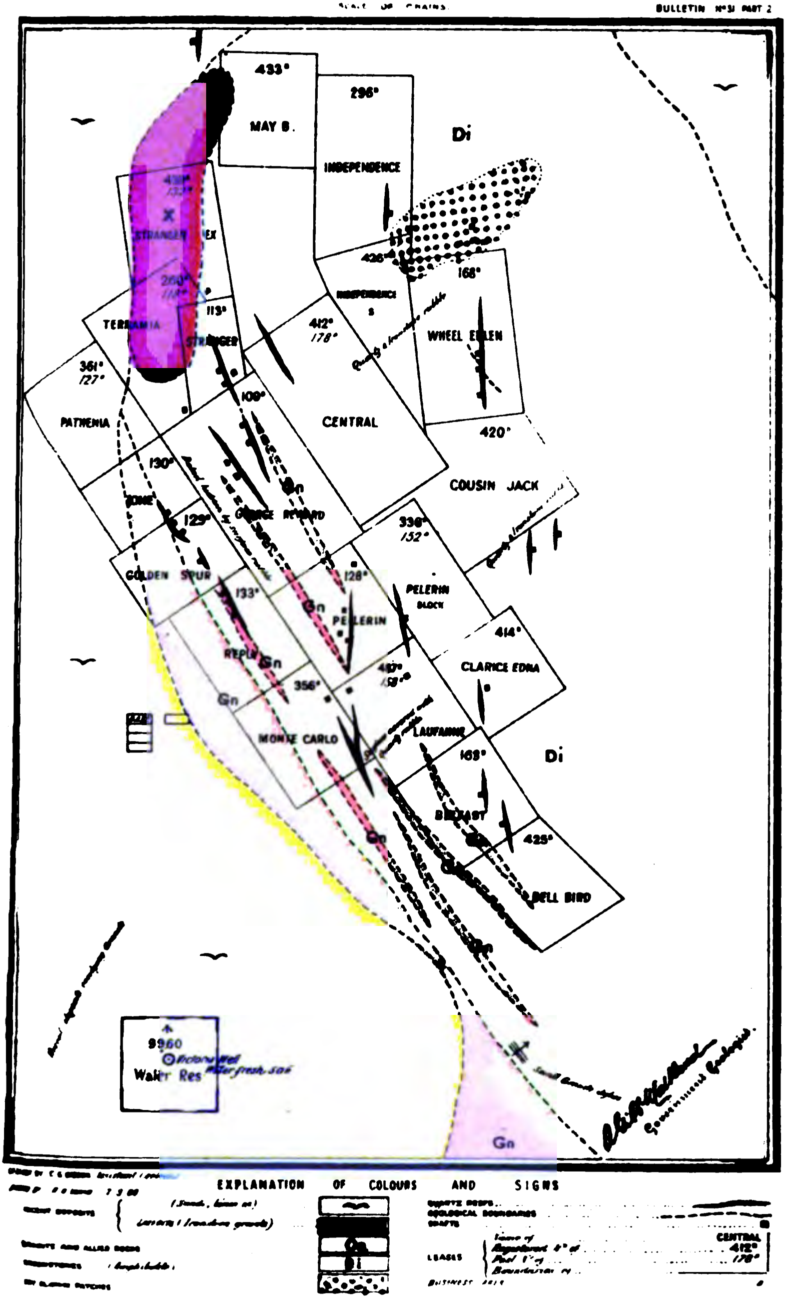
GEOLOGICAL SURVEY OF WESTERN AUSTRALIA

BIRRIGRIN

EAST MURCHISON G. F.

BULLETIN Nº 31 PART 2



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GOVERNMENT ASSAYS.

Assays, Analyses, and Determinations of any Western Australian Ore or Rock will be made by the Assayer to the Geological Survey, *when not unduly interfering with official work*, subject to the following conditions:—

1. Each sample must weigh at least 6 ozs., but not more than 2 lbs.
2. Each sample must be enclosed in a separate canvas bag or strong paper wrapper, with a slip of paper bearing the name and address of the sender, together with a private mark by which it may be readily identified.
3. The parcel must be forwarded, *prepaid*, to:—

The Government Geologist,
Geological Survey Office,
Perth.

4 A letter must be sent at the same time to the same address, stating for what metals the samples are to be assayed, or containing other instructions, as the case may be.

(N.B.—It is always advisable to keep duplicate samples of those submitted.)

5. Before any assay is made the prescribed fee must be paid to the Mineralogist and Assayer, or sufficient reasons, in accordance with Section 7 below, be furnished for having the samples treated free of cost.

6. The following fees will be charged:—

	£	s.	d
(*a.*) Determination of a Rock or Mineral ...	0	10	6
(*b.*) Assay for Lead, Iron, or Manganese, each	0	10	6
(c.) Assay for Silver, Copper, or Tin, each	0	12	6
(*d.*) Assay for Gold or Zinc, each	0	15	0
(*e.*) Dry Assay for Lead, Silver, and Gold	1	1	0
(*f.*) Assay for Antimony, Bismuth, Chromium, Cobalt, Mercury, or Nickel, each	1	11	6
(*g.*) Proximate Analysis and Calorific Valution of Coal	1	11	6
(*h.*) Complete Chemical Analysis of any Mineral or Ore, according to number and nature of determinations, £2 12s. 6d. to	5	5	0
(*i.*) **Other determinations, according to time** spent, up to	2	12	6

A reduction of 20 per cent. on the above amounts will be made in favour of any person submitting, in one parcel, five or more samples for identical treatment.

7. With the object of encouraging *bonâ fide* prospecting, Free Assays will be made under the following circumstances:—

(*a.*) The sample must have been obtained from land within the State not held under lease for mining purposes.

(*b.*) The exact locality where the sample was found must be disclosed.

(*c.*) The sample must be of sufficient promise to warrant an assay being made at the expense of the State.

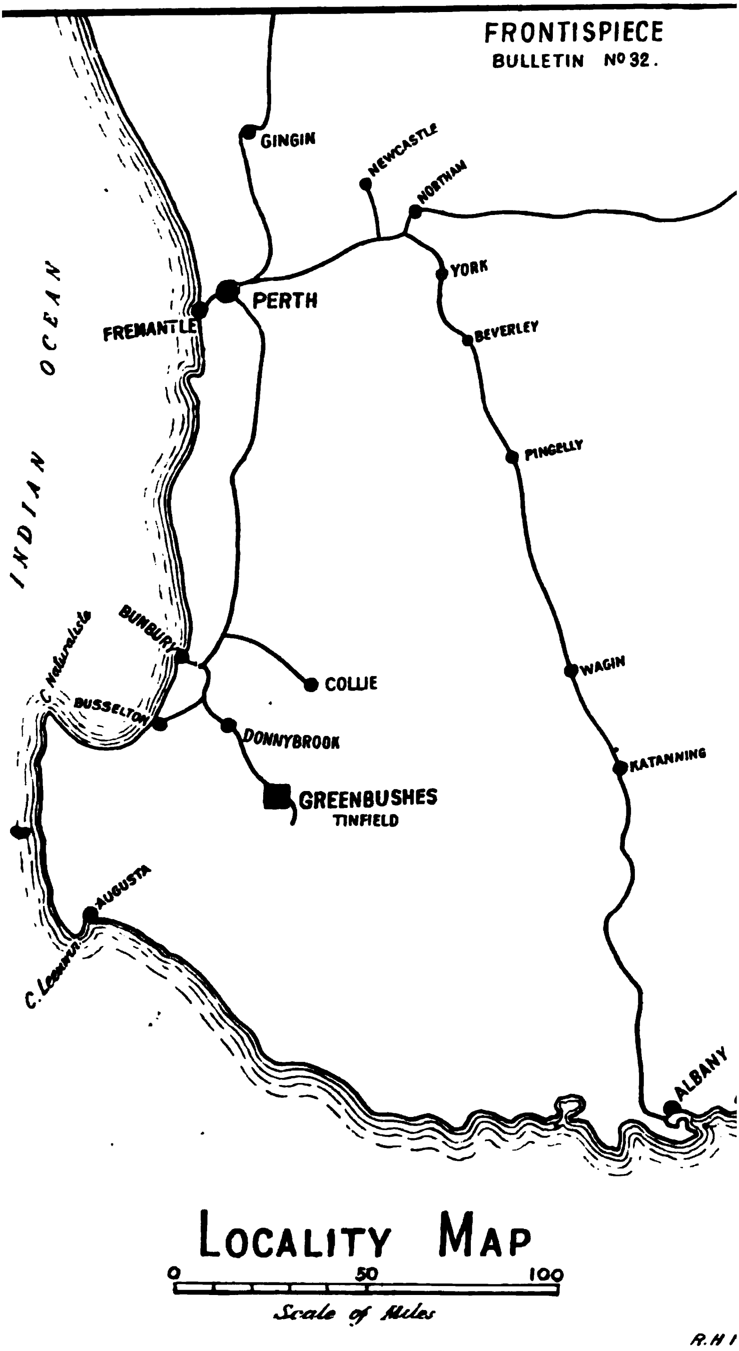
(*d.*) Free Assays will not be made of samples showing free gold, or of tailings or other metallurgical products, or of umpire samples.

8. The Department reserves to itself the right of refusing to make any particular Assay, and also the right of publishing at any time the results of an Assay made at the public expense.

A. GIBB MAITLAND,
Government Geologist.

1M.1108—By Authority: The Galwey Printing Co., Lane St., Perth.

FRONTISPIECE
BULLETIN No 32.



LOCALITY MAP

1908.

WESTERN AUSTRALIA.

GEOLOGICAL SURVEY.

BULLETIN No. 32.

I.—NOTES ON THE GEOLOGY OF THE

GREENBUSHES TINFIELD.

(WITH SPECIAL REFERENCE TO THE DEEP LEADS.)

II.—A REPORT UPON THE

MOUNT MALCOLM COPPER MINE.

EULAMINNA, MOUNT MARGARET GOLDFIELD.

III.—A REPORT UPON

FRASER'S GOLD MINE, SOUTHERN CROSS,

YILGARN GOLDFIELD.

BY

HARRY P. WOODWARD
Assistant Government Geologist.

Issued under the Authority of the Hon. H. Gregory, M.L.A., Minister for Mines.

WITH MAPS, PLATES AND FIGURES.

PERTH:
BY AUTHORITY: R. S. SAMPSON, PRINTER, KING ST., PERTH.
1908.

PREFATORY NOTE.

AS this report on the Greenbushes Tinfield is to accompany a re-survey of the district, it has been considered advisable to draw largely upon previous official publications, thus bringing together all the available data and the opinions expressed by other officers who have previously examined this field. A further reason for this being that many of these reports were written at a time when work was in progress at certain points, which have since then been worked out and abandoned or are at present inaccessible to inspection.

The reports drawn upon are :—By A. Gibb Maitland, Government Geologist, "Notes on the Greenbushes Tinfields," Annual Report of the Department of Mines, 1899, and "The Present Conditions and Future Prospects of the Greenbushes Tinfield," Annual Report of the Department of Mines, 1900 ; by A. Montgomery, M.A., F.G.S., State Mining Engineer, "Notes Upon the Greenbushes Tinfield," Annual Report of the Mines Department, 1903 ; by W. D. Campbell, Assistant Geologist, "Recent Mining Developments at Greenbushes," Annual Report of the Mines Department, 1905 ; whilst the Tin section of the Baser Metals Bulletin No. 30, compiled by Mr. E. S. Simpson, B.E., F.C.S., has also been incorporated.

The map issued with this report is a reproduction brought up to date of that prepared by Mr. A. Gibb Maitland, the Government Geologist in 1899, his Geological lines being transferred to the contour survey prepared by Mr. H. W. B. Talbot, Topographical Surveyor to this Department, the area covered being 36 square miles, whilst the geological work has been added to and extended to the boundaries of the field by myself.

Reports upon the Mount Malcolm Copper Mine at Fulaminna and Fraser's Gold Mine at Southern Cross have also been included in this Bulletin.

HARRY P. WOODWARD,

Acting Government Geologist.

Geological Survey Office,

18th March, 1908.

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Tin Crystals 10

PART 1.

Notes on the Geology of the Greenbushes Tinfield with special reference to the Deep Leads.

INTRODUCTION.

The Greenbushes Tinfield is situated in the South-Western division of the State upon the Bunbury-Bridgetown railway line, 159 miles from Perth.

It covers an elevated tract of country upon the northern side of the Blackwood River, the highest point in the district being near the centre of the field, where it attains an altitude of 1080 feet above the sea level.

From this point the gullies radiate in all directions, but eventually discharge themselves into the Blackwood River, often by circuitous routes, having cut in their courses steep rough valleys.

The whole area is densely covered by some of the finest Jarrah and Blackbutt timber in the State, which should in the future, if conserved, prove a most valuable asset to the mines.

The average rainfall is 36.75 inches, but, owing to the hilly character of the country, there is no permanent surface water nearer than the Blackwood River, some five miles distant, but an abundant supply of excellent water can be obtained by sinking; the depth at which it is struck, varying from 10 to 100 feet, according to the elevation and nature of the country.

The history of this field may be said to start about the year 1881 or 1882, when the late Mr. E. T. Hardman, who was at that time Government Geologist, made a flying survey of the South Western District. When camping at the Greenbushes well he was struck by the stanniferous character of the material excavated from it, and made mention of it in his report, which appeared in the press.

Whilst upon this trip, Mr. Hardman met Mr. D. W. Stinton, who, being engaged at the time in kangaroo hunting, was able to materially assist him with information owing to his intimate knowledge of the district.

It appears that Mr. Hardman advised Mr. Stinton to prospect for tin in this locality, which he did, with the result that in the latter part of 1888 his labours were rewarded by the discovery of what was afterwards known as the Bunbury Lease.

Upon this discovery becoming known a large number of persons visited it from Perth and, elsewhere, and made applications for mineral leases under the old Mineral Land Act, whereby they could take up blocks of 100 acres in extent without the necessity of fulfiling labour conditions, the consequence being that a very large number of areas were secured for purely speculative purposes, but in spite of this we find that 504 tons of black tin were produced in the year 1891.

From this time onward to 1896 the price of tin gradually fell, and, as will be seen from the table of production attached, in that year it only realised the low figure of £31/12/- per ton (tin oxide), the consequence being that mining came practically to a standstill, and the field was nearly deserted.

With the revival to £78/2/- per ton in 1899, a great influx of population took place, and the mining laws having been re-cast, the field was taken up as a number of small holdings.

Subsequently to this, in spite of the fall in 1901 to £55 : 10/- per ton, this field as a mining centre became permanently established, whilst the annual output steadily increased year by year, the maximum being reached in 1906, when 783½ tons of ore were shipped, which realised the high price of £101 per ton.

When the limited area covered by stanniferous deposits is noted, it will at once be apparent that the wash must originally have been of considerable richness, but, owing to the lack of system in working it, in the early stages of the field, the same ground has in several instances been re-worked more than once, the last occasion being in 1906, when tin values stood so high, that even dumps of tailings and hopperings of low value paid well to re-treat.

This day has passed, however, and, without the price of tin materially increasing (which will render large deposits of low grade dirt payable), or discoveries of new rich leads are made, the lode mining must be looked to as the future of this field, for when once the known gullies have been swept by the hydraulic sluicing plants now upon the ground, very little of value will remain.

A very considerable volume of official literature bearing upon this area has been issued by the Mines Department, commencing in the year 1889, when a report upon the country between Bunbury and Bridgetown, the Tinfields and Albany, was issued in the Annual Report for that year by myself, at that time Government Geologist, whilst in the following year another report was published. In the Ad. Interim Report of the Department of Mines for the half year ended 30th June, 1894, I published a further report, accompanied by a map, upon which the probable course of the ancient stream beds is marked. Subsequent reports were issued in the Mining Handbook to the Colony of Western Australia in the years 1894 and 1895 (under authority), also by myself. Other reports were subsequently made by other officers of the Mines Department, reference to which is made in the preface to the present work.

These various reports have necessarily dealt very fully with the various alluvial claims in existence at the time of publication, but since these are of little interest at the present, since they are practically worked out, the original matter in this report will be principally confined to the potentialities of the field, which are centred in the deep leads and the lodes.

The map which accompanies this report has been issued upon a fairly large scale in order that the detail may not be lost, it is practically a reproduction of that issued by the Government Geologist in 1899, which has been brought up to date by the addition of recent workings and existing leases, while the geological lines have been extended to the boundaries of the field. In order to be in a position to delineate the course of the old stream beds (deep leads) with considerable accuracy this field has been topographically surveyed by Mr. H. W. B. Talbot, of this Department, and his work shows the contour lines at intervals of elevation of 10 feet, which will be found of considerable value.

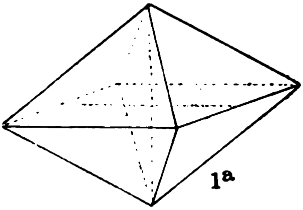
Table shewing [illegible] of the Greenbushes [illegible].

Year.	Ore Produced	Value.	Value per ton.
	Tons	£	£
1891	204·00	0,200	50·00
1892	265 49	13,843	52·14
1893	171·50	7,664	44·68
1894	371·25	14,325	38·58
1895	277·15	9,703	35·01
1896	137·25	4,338	31 60
1897	95·55	3 275	34·27
1898	68·14	2,760	40·50
1899	277·32	21,658	78·10
1900	435·62	29,528	67·78
1901	321·34	18,852	55·55
1902	403·21	24,680	61·20
1903	524·94	34,362	65·45
1904	533.64	34,462	64·57
1905	643·52	52,960	82 29
1906	783·28	79,196	101·10
1907	770·00	73,045	94·86
Total...	6,283·20	434,850	69·20

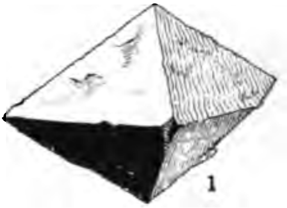
GENERAL.

TIN.—The only ore of tin which has been worked upon this field is cassiterite, of which the following is a brief description :—

CASSITERITE (Tinstone, Black tin, Stream tin, Lode tin).—Oxide of tin SnO_2 containing from 68 to 78 per cent. of Metallic tin. It occurs either crystalline, massive or as rolled grains, the former belonging to the tetragonal system mostly as octahedrons, often truncated or bevelled, and frequently twinned in the most complicated manner. (See Figure.) In colour it is either black, blue-black, brown, red, or grey ; translucent to opaque. Hardness, 6 to 7, brittle. Specific Gravity, 7.0.



1a



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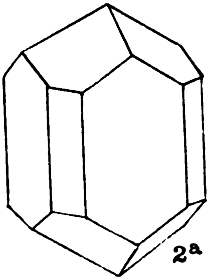

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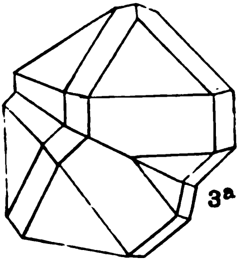

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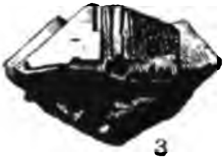

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TIN CRYSTALS.

Tin oxide is, however, also a constituent of several well-defined mineral species which constitute ores of tantalum (q.v. p. 22). The amount present in these is, however, small and unimportant commercially, varying from a mere trace up to at most two per cent.

The presence of tin is usually denoted by small bright black or greyish stones of great weight for their size, which feature enables them to be easily separated from the sand and clay (with which they are usually associated) by means of washing with a dish or dryblowing. This ore is always found in close association with granite rocks, especially those which carry tourmaline, lithia mica, or tantalum ores.

Tin ore is often met with in the alluvial wash of stream beds (when it is called stream tin), but in the North-West, where no concentration has taken place owing to the flatness of the surface and the small rainfall, it is also found strewn over the surface of the plains and embedded in the shallow soil of gentle slopes.

These alluvial deposits are generally derived from the weathering of the stanniferous pegmatite dykes, which are coarse granites containing large crystals of felspar, mica (sometimes in large enough plates to be of commercial value), and ragged quartz, and often also black six-sided crystals of tourmaline, the enclosing country rock in this field being always crystalline and mostly basic.

Stream tin is generally more or less rounded, having a bright polished surface, whilst the lode tin, when in crystals, has often eight sides, and in form is like two four-sided pyramids joined base to base , both of these forms may be coated with a thin ferruginous covering of a dark chocolate colour, but when broken the bright resin-like fracture so characteristic of tin oxide will be at once observed.

The principal characters by which tin ore may be recognised are its high specific gravity or weight, the brilliant lustre of its fracture, its streak or powder, which is of a grey or brownish-grey colour, and also by the fact that it is fused with the greatest difficulty alone, but yields a bead of metallic tin when treated with carbonate of soda or cyanide of potassium upon charcoal before the blowpipe, or in a crucible in a forge or furnace ; the metallic tin being easily distinguished from any other metal by the peculiar crackling sensation it produces when pressed between the teeth. Tin, in any form, is no magnetic, and therefore it will neither attract the needle of the compass nor can fragments be picked up by a magnet either before or after fusion.

It is easily distinguished from the majority of minerals by its weight, but it may be confused with any of the five following heavy minerals, particularly if in small fragments, when the difference in weight is not so readily appreciated :—

The first three, viz., magnetite (magnetic iron ore, lode stone), ilmenite (titanic iron ore), and rutile, although not nearly so heavy as tin, are often mistaken for it, but they may be distinguished as follows :—Magnetite by its magnetic properties and black streak or powder. Ilmenite (black sand) gives a black streak and becomes magnetised after heating to redness with charcoal, and in the form of a powder when washed in a dish runs, with a glittering appearance, whilst if the finger is damped and dipped into the ordinary black sand it will adhere to it, whilst tin will not. Rutile is more difficult to distinguish from the preceding, the most noticeable points being that it does not possess the brilliant fracture of tin ore, and its streak is reddish-brown ; however, the only reliable test is that it will yield no tin with the blowpipe or by smelting.

In the case of wolfram and tantalite, whose weight is so similar to tin, this property cannot be taken advantage of, but since wolfram fuses easily to a magnetic bead, it can be quickly determined ; whilst in the case of tantalite, a freshly fractured surface is much more stony looking than that of tin ore ; but the non-production of a tin button after fusion with soda or cyanide is always conclusive.

An exceedingly good and simple test has recently been made public for the detection of tinstone (cassiterite) in concentrates or other material. The only apparatus required is a small ingot of zinc containing a hollow in the top about the size of the bowl of a teaspoon, (or a small sheet of zinc bent up to hold about a teaspoonful of acid) and a small bottle of dilute hydrochloric acid (muriatic acid or spirits of salt) consisting of half strong acid and half water. A small quantity of the concentrates is spread over the bottom of the hollow in the zinc and then covered with the acid. After two or three minutes the acid is washed out with clean water and the ore examined. All the fragments of tinstone will be found to be coated with a skin of bright metallic tin, whilst no other mineral will be so coated. This distinguishes at once tinstone from other minerals resembling it, such as tantalite, ilmenite, rutile, etc., and can be used to give a rapid idea of the purity of concentrates.

NOTES BY MR. A. GIBB MAITLAND, GOVERNMENT GEOLOGIST, PUBLISHED IN THE ANNUAL REPORTS OF THIS DEPARTMENT FOR 1899 AND 1900.

"In its geological features the field consists for the most part of crystalline rocks (of the age of which the district affords no clue), alluvial deposits, and ferruginous laterite, sometimes conglomerate, which covers by far the larger portion of the tinfield.

"This laterite conglomerate, which forms one of the most noticeable features in the structure of the field, has been accurately delineated upon the geological map with which these notes are accompanied. In its mode of occurrence the laterite presents one important feature, viz., that it does not form a horizontal tableland, but occurs at different elevations, and seems to have adapted itself to the original contour of the ground upon which it originated. This deposit covered a much larger area than it at present occupies, and denudation has gone on to a large extent since it formed part of one continuous formation; the thickness of it is nowhere very great, operations having shown that it rarely, if ever, exceeds 20 feet. The laterite is not of sedimentary origin, but has apparently been formed by the alteration *in situ*, and subsequent cementation of the underlying rocks. In some portions of the field this formation (as is only to be expected from its mode of origin) carries a certain quantity of tin. The ore, however, is not evenly distributed throughout, but seems to be concentrated in certain isolated patches. The tin from the laterite cannot be extracted by the ordinary process of washing without milling. Where the tin proves most concentrated in the conglomerate it is doubtless due to the fact that it is in close proximity to the tin-bearing granite. It, however, by no means follows that the granite must of necessity be exceptionally rich in tin, for the reasons that such minerals as tin, etc., not being readily acted upon by atmospheric agencies, may, owing to residual concentration, be present in far greater quantity than in the parent rock mass.

"In addition to the above, a fairly large proportion of the tin ore is derived from the alluvial deposits formed in the existing valleys. These alluvial deposits do not attain very great thickness, nor, considering all things, do they cover a relatively large area of ground.

"The crystalline rocks (the matrices of the tin ore) consist of micaceous granite, passing in places into a foliated and highly micaceous granite, with little or r felspar. This granite (greisen) contains tin, tourmaline, zircon, garnet, etc., as accessory constituents. In some parts of the field the tourmaline occurs in such quantity in the greisen as to give a distinctive character to the rock, and would be better described as a tourmaline-gneiss. Some specimens of this material from Caporn's Deep Shaft (now known as the "Cornwall") yield, on assay, tin to the extent of 1.79 parts per hundred."

"The primary tin-bearing deposits of Greenbushes have been described as stanniferous granites and greisens and not lodes, upon the grounds that they do not conform to the accepted scientific definition of the latter, at the same time it must be clearly understood that this classification does not imply that the ore bodies upon this field are of any less value, or that they will not be as extensive in depth as if they belonged to the lode order, for, as they owe their origin to deep-seated agencies, they are likely to be as permanent as any such can be.

"Owing to the extremely low assay value of many consignments of what were apparently perfectly clean tin ore, which had been shipped to Melbourne, Mr. J. J. East, of the South Australian School of Mines, was induced to undertake a mineralogical examination of the ore. Amongst the ore was a mineral varying from a dirty greenish white to a dark flesh colour, having about the same specific gravity as cassiterite, rendering it impossible to separate the two mechanically. Qualitative tests proved the mineral to be one of the ores of antimony, which, on chemical analysis at the hands of Mr. G. A. Goyder, the Government Analyst, showed it to contain oxide of antimony, bismuth, nickel, niobium, tantalum, together with a trace of iron oxide ; the mineral had a specific gravity approaching that of cassiterite, so that no gravity concentration would separate the two minerals.

"From the above descriptions it will be seen that (a) the superficial deposits have been extensively worked and continue to yield quantities of tin ; (b) the deposits in country rock have also been opened up, though save in one or two localities they do not appear to be very rich in tin. Whether these latter deposits can be made to pay can only be determined practically. Owing to the absence of suitable mechanical appliances for dealing with the ore, once it is raised, no mining for 'lode tin' can be carried out under present conditions at greater depths than the zone of decomposition.

"The occurrence of stibiotantalite, as well as the mineral tantalite, has been recognised in various localities, viz., Spring Gully, Floyd's Gully, Bunbury Gully, and Elliot's Gully. The presence of the former mineral having such a deleterious effect upon any of the dressed ore with which it may be associated, it seems desirable that steps might be taken to ascertain the localities where this occurs in the greatest quantities. A method which naturally suggests itself is, in the event of a State dressing plant being erected, to have assays made of each parcel of dressed ore treated at the works, and any parcel in which the mineral occurs could very well be smelted separately, and so avoid contaminating the whole of the tin from the field.

"As stated, in previous reports, the future of the field, after the exhaustion of the superficial deposits, will depend upon the economical working of the ore deposits occurring in the country rock, and that can only be carried out by the admission of capital upon advantageous terms, so as to admit of a proper system of scientific mining being inaugurated."

NOTES UPON THE GREENBUSHES TINFIELDS BY MR. A MONTGOMERY, M.A., F.G.S., STATE MINING ENGINEER, PUBLISHED IN THE REPORT OF THE DEPARTMENT OF MINES FOR THE YEAR 1908.

"The bedrock is very poorly exposed, but there appear to be some three or four more or less parallel belts of stanniferous granite running through the field on a course between north and south and north-west and south-east. As far as I could see they were not definite lodes, but rather of the nature of stockworks, that is, belts of the granite much altered by pneumatolytic agencies, and impregnated with tin ore and tourmaline. The altered granite is very micaceous, with large scales of white to greenish mica, but sometimes is also altered to a granular quartz rock, almost free from mica. Much tourmaline is present, often in large crystals. The stockwork granite also contains small quartz veins, which occasionally seem of sufficient importance to be called small lodes. Much kaolin and talcose and sericitic matter is present, the rock being very variable in its composition. It is very similar, in its essential characteristics, to the tin bearing rock of the well-known stockworks of the Blue Tier in Tasmania, with which I am familiar, and which are regarded as portions of the granite country much altered by pneumatolytic action, that is, by the action of super-heated steam and hot gases while buried deep below the surface of the ground. This action is akin to that by which most probably regular tin lodes have been formed, but has affected a considerable mass of rock, instead of being confined to a lode fissure.

"The general experience of stockworks is that they are of low grade on the whole, though containing numerous rich bunches and strings of ore, and containing, in the aggregate, often enormous quantities of tin. Where they have become worn away at surface they set free large amounts of alluvial ore, which readily becomes concentrated, by natural agencies, to form important deposits. The distribution of the tin in stockworks is usually very irregular, being sometimes right through and through the rock, but more frequently in small veins and strings ramifying irregularly through it. As a rule these veins are too irregular to be capable of being followed by mining, and the proposition, from a mining point of view, narrows itself down as to whether the tin-bearing rock will pay to handle in bulk.

"The principal source of the tin ore raised at Greenbushes has been the shallow alluvial deposits which are fairly widely spread, having been worked in several somewhat flat gullies that traverse the field. The principal one is 'Spring Gully,' from which, with its branches, a large amount of tin ore has been taken from very shallow workings. Much of the tin ore, however, is in cemented oxide of iron gravel, and requires battery treatment to set free the tin. In other portions the 'wash' is clayey and soft, and puddling is sufficient to extract the clean ore. Occasionally the 'wash' is buried under 10 to 15 feet of iron oxide gravel, as in Mr. Rattray's mine. At the head of 'Dumpling Gully' there is also some fairly deep alluvial 'wash' requiring underground mining, and some of the claims in this deep and wet ground have been considerable producers of tin ore. This 'wash' is mostly treated without difficulty, by puddling without crushing. The Lady Esther lease is at the head of the Dumpling Gully, and on it there is a deep hole, filled with water at the time of my visit, from which a considerable amount of tin ore has been extracted, until the influx of water became so great that it was not possible to continue with the plant then available. The ground is still deep going to the south-east, and it seems possible that there may be a run of deep ground going through to the head of Salt Water Gully. Boring would be the quickest and easiest way of testing this deep ground. The 'Bunbury Gully' has been shallow ground all the way down, and has been pretty well worked out; but at the lower end there is a deposit or deep alluvial ground, through the Hard Graft and adjoining claims, which appears to belong to an entirely older set of alluvial deposits, and to be part of a 'deep lead.' In this the 'wash' is composed of large well-rounded boulders, and the tin ore is much rounded and waterworn. Some of it is cemented with oxide of iron and requires crushing. I had not time to more than look over the dumps of a few of the claims in this part of the field, but the evidence of a 'deep lead' was very obvious. It seemed to run across the course of the present valley, towards the Battler's Hope, and prospecting along this line seems very desirable.

"In a district which has produced such a quantity of tin ore from the shallow ground it is probable that any deep leads will be found to contain important concentrations of ore also, and the tracing of such deep leads therefore becomes a matter of much consequence to the whole district. It is probable that in the 'gutter' the lead will be pretty wet, and will require fairly good pumps for its drainage.

"The Greenbushes field, though it has been a very payable one on the whole, is still very little developed, and as the shallow alluvial deposits are becoming more or less worked out, will have to depend more and more as time goes on on the opening up of the deeper alluvials and the stockworks. The possibility of working the latter at a very low content in tin ore seems to be the most important problem to be solved, and on it will greatly depend the future of the district. There is a certain small amount of data to go upon that indicates that there is a chance of handling these stockwork deposits at a profit but a great deal of systematic prospecting has yet to be done before sufficient proof would be forthcoming to warrant the erection of the extensive plant that would be necessary to treat ore of very low grade successfully."

* "The geological structure of the field is as follows :—The tops and slopes of the ridges are covered by a thin compact capping of laterite, consisting of a mixture of bauxite and limonite, the former usually predominating. In places a very pure iron ore is found, and has been largely used by the Fremantle Smelting Company as flux. This laterite is due to the concentration at the surface, by capillary upward movement of water solutions, of the alumina and iron oxide leached out from the underlying crystalline rocks. Immediately below the laterite these rocks are represented by clays (leached rock), formed *in situ*, and these gradually pass into the crystalline ground rock. The main mass of the latter is granite, foliated in places, and outcropping in the steep sides of the numerous gullies. It is typically coarse-grained and micaceous. Dykes of greenstone, in places (as at the Cornwall Mine) altered to hornblende schist cut through the granite.. Two samples of the uncrushed rock, one (7000) from Loc. 991, the other (5198) from Bunbury Gully, are both bronzite-diabases composed of plagioclase, augite, bronzite, hornblende, and ilmenite. The primary ore bodies appear to be either (1), highly foliated bands of granite (shear zones similar in structure and origin to the auriferous greenstone lodes of Kalgoorlie) impregnated with secondary cassiterite, topaz, tourmaline, etc. ; (2), albite pegmatite veins or dykes ; (3), quartz-tourmaline veins or dykes. Some veins also of these types exist which are not tin-bearing at all.

"The secondary ore deposits are of two types (1), Residuary deposits, including laterite and residuary clays and sands, representing rock decomposed *in situ*, and in which angular ore occurs in its original position. These are of minor importance ; (2), True alluvial deposits. The swampy flats and narrower stream beds are filled with a very variable thickness of true alluvial material. Sometimes the alluvial ore is buried to a depth of 50ft. or 60 ft., and in places is of sufficient age to have become consolidated into a hard ferruginous conglomerate. Mostly, however, the alluvial is under 20ft. deep, and is composed of loose sand, clay, or low level laterite gravel. It is deposits of this nature which have yielded by far the greater portion of the tin output up to the present. Within the last two years, however, more attention has been paid to the lodes, and each month sees the addition of more mines to the list of those producing lode ore."

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* Geol. Surv. Bulletin No. 30.

THE FOLLOWING NOTES ARE BY MR. E. S. SIMPSON, B.E., F.C.S., MINERALOGIST AND ASSAYER TO THE DEPARTMENT, MOST OF WHICH HAVE ALREADY APPEARED IN PRINT IN BULLETINS NOS. 6, AND 30, AND THE ANNUAL REPORT OF THIS DEPARTMENT FOR 1899.

PRIMARY DEPOSITS.--The most important of these are the pegmatites composed essentially of albite and quartz, with or without muscovite, garnet, tourmaline, topaz, orthoclase, tantalite and cassiterite. The most important of these deposits occurs within a belt of greenstone and greenstone schist. They are probably not dykes in the sense of being fissures filled by sheets of originally molten rock, but are more probably closely related to ordinary "lodes," being the result of hydrothermal action. The tin may have been introduced into them in vapour or solution of tin fluoride, which has been acted upon in the fissures by carbonate of lime, or even felspar, with the production of tin oxide and such minerals as topaz and tourmaline. Such deposits may be expected to extend to very great depths without diminishing in ore value, the numerous small veins found near the surface coalescing to a large extent as depth is reached.

Above the water level these veins are often highly micaceous and foliated to a considerable extent. At the South Cornwall mine a very micaceous and foliated lode composed of pale green muscovite, quartz, topaz and coarse cassiterite yielded from near the surface what was probably the richest lodestuff yet raised on the field ; see specimen (4660) in the Geological Museum. A large specimen (7198) from a depth of 130 feet recently received from this mine is a compact banded lode composed mainly of albite with quartz, tourmaline, topaz and cassiterite. A still more recent sample from a depth of 150 feet contained 1.09 per cent. of tin, together with a little arsenical pyrites. The average yield of ore from this lode has been 0.55 per cent. of metallic tin. A crystal of clean cassiterite from this lode was found to contain 76.9 per cent. of metallic tin, and to have a specific geavity of 7.15.

Bulk samples from the Cornwall mine of a foliated ore composed of albite, tourmaline, muscovite and quartz gave assays of 1.79, 0.55, 3.46 and 1.09 per cent. ; these samples wese obtained from above the 150 feet level.

A highly micaceous lode in the Enterprise mine has yielded a fair amount of tantalite, *vide infra*.

SECONDARY DEPOSITS.—The denudation of the many tin-bearing lodes and other primary deposits has led to a considerable concentration of ore in laterites, residuary clays and sands, and in the true alluvial deposits of the swampy flats and water courses. In the residuary deposits some of the ore is very coarse, but in most of the secondary deposits is fine, being usually under one-tenth of an inch in diameter, though but little appears to be under one-sixtieth.

Pure tin dioxide contains 78.6 per cent. of the metal, but the native ore, "tinstone" or "cassiterite," invariably contains more or less chemically combined oxides of iron, aluminium, calcium and magnesium, so that clean cassiterite seldom assays over 74 per cent. of the metal. A coarse fragment of clean alluvial ore from North Greenbushes was found to assay 71.6 per cent. of tin. All bulk lots of alluvial concentrates are invariably of still lower grade, owing to the presence of other heavy minerals which cannot be, or have not been, completely dressed out of them by the miners. Under ordinary circumstances, however, carefully dressed ore should not contain much less than 67 per cent. of the metal being free from all minerals with a specific gravity under 4.5.

The chief constituents of the secondary ores at Greenbushes are quartz and clay, with lesser proportions of iron oxide and tourmaline. These are all of low specific gravity, and therefore seldom appear in appreciable amounts in the dressed ore. Accompanying the cassiterite are, however, numerous heavy minerals derived from the tin lodes and from the rocks enclosing them. Ranged in approximately relative order of frequency these minerals are ilmenite, zircon, rutile, magnetite, staurolite, gahnite, tantalite, stibiotantalite, kyanite and native tin. According to the efficiency of the dressing plant these minerals are present in quantities varying from traces up to about 40 per cent. in first grade concentrates and to 80 per cent. in "seconds."

In the accompanying table details are given with respect to several such concentrates so far as size of grain, component minerals and content in tin are concerned.

Tin Concentrates, Greenbushes.

G.S.M. No. ...	698	1285	...	...	7914	...	7838	7839	697
G.S.L. No. ...	430C	431C	3579B	3580B	173C	196C	95C	94C	451C
Sample ...	1sts.	1sts.	1sts.	2nds.	2nds.	2nds.	2nds.	2nds.	2nds.
Claim ...	Sinclair's	Gibney's	Armstrong's	Elliott's	Spittle's	Kosky's	Portwood & Bonnor's	George's	Sinclair's
Locality ..	Spring Gully	Dumpling Gully	Floyd's Gully	Elliott's Gully	Battler's Gully	Bunbury Gully	Elliott's Gully.	Battler's Gully	Spring Gully
Metallic Tin, per cent. ...	66.71	65·01	32·89	34·76	17·68	30·48	19·79		
CONSTITUENT MINERALS:									
Cassiterite ...	4*		4	4	3	4	3	3	3
Ilmenite ...	...		4	3	4	4	4	2	2
Zircon ..	2		2	3	3	1	2	4	2
Quartz ...	1		2	1	...	1	...	...	1
Tourmaline ...	...		...	...	...	3	...	...	...
Rutile ...	...		2	...	1	...	2	...	1
Magnetite ...	...		...	...	1	...	2	...	1
Staurolite ...	...		...	...		1	...	...	...
Gahnite ...	1		1	1	1	...	...	1	2
Tantalite ...	2		...	...	...	...	...	...	...
Stibiotantalite ...	...		..	...	...	...	...	...	1
Garnet ...	...		...	...	...	...	...	...	1
Kyanite ...	...		...	1	...	...	..	...	1
Limonite ..	...		...	...	...	2	...	...	1
Native Tin ...	...		...	...	...	...	...	...	1
SIZE OF GRAIN:									
>10 per cent...	nil	7·4	3·5	nil	nil	20·3			
>20 <10	18·0	40·6	15·6	.2	trace	10·7			
>40 <20	61·9	30·8	26.3	23.7	1.0	9·2			
>80 <40	19·1	20·7	40.8	70.9	73.0	32.7			
<80	1·0	·5	13.8	5.2	76.0	27.6			

* NOTE: These numbers indicate the relative quantities of each mineral present.

ILMENITE (titanate of iron) is usually mainly responsible for the low assay value of poor concentrates. It is possible to remove it by at least three different ways :—(1) By careful reconcentration by water of the first concentrates, its specific gravity being considerably below that of cassiterite. A sample from Bonnor's claim was on my recommendation thus treated, and the grade was improved from 20 per cent. tin to 63 per cent. (2) By magnetic concentration. (3) By sifting through a screen of about 40 meshes to the linear inch, the coarser product thus obtained being mainly tin ore, the finer ilmenite.

ZIRCON (silicate of zirconium) is very plentiful in most of the low concentrates. It is usually in very small well formed crystals, colourless or rarely violet, yellow or light brown. Its specific gravity is only 4.6, so that method (1) above should separate it. Method (3) has also been found successful, the zircon being invariably much finer grained than the great part of the associated cassiterite.

QUARTZ and TOURMALINE are absent from all carefully dressed ore. The latter, being black in colour, is sometimes retained in samples under the impression it is tin ore, and therefore not to be allowed to go off in the tailings. Much of the quartz is of a peculiar smoky tinge and granular structure.

RUTILE (oxide of titanium) appears to be plentiful in some claims east of the main ridge. It is dark brown in colour, sometimes very coarse, sometimes very fine grained. Its specific gravity being only 4.2, careful reconcentration should remove it.

MAGNETITE is not very common. Reconcentration or magnetic treatment should separate it.

STAUROLITE (hydrated silicate of iron and aluminium) is occasionally seen in the ore. Its specific gravity is only 3.7, so it should not be difficult to remove. In one part of the field concentrates consisting wholly of this mineral have been obtained ; see specimen (8453) in the Geological Museum.

GAHNITE (aluminate of zinc). Small well formed octrahedral crystals of this mineral are to be seen in very many samples of ore. They vary in colour from pale to very dark green. Specific gravity 4.6. They are especially plentiful in a sample from Spring Gully (697).

GARNET and KYANITE (silicate of aluminium) occur in occasional fragments in the stream ore, the former bright red in colour, the latter colourless to blue.

NATIVE TIN. From sample (697) from Spring Gully ten small non-magnetic particles were picked out. These particles were partly rounded and partly flattened, and under the microscope were seen to be tin-white in colour with a roughened surface, in which were embedded grains of quartz, etc. They are sectile and dissolved readily in strong hydrochloric acid, yielding a solution which gave reactions for tin but not for lead, zinc or iron. The particles were undoubtedly metallic tin, which, according to Dana, has only been with certainty recognised in one other locality, viz., at Oban, in New South Wales. In both cases bush fires raging over surface exposures of tin ore may account for the origin of the metal.

TANTALUM.—The two rare metals tantalum and its twin brother niobium, are nowhere found in the native state or in sulphides or other similar minerals. They exist always in combination with oxygen, and one or more other metals, the oxides having an acid character and giving rise to tantalates and niobates. They invariably occur in conjunction, replacing one another isomorphously to a very variable extent, the niobate of a metal often passing by insensible gradations into the tantalate without change of form or physical characters other than a corresponding gradual rise in specific gravity, tantalum having an atomic weight double that of niobium. In the following pages therefore whenever a mineral is described as a tantalite it must be understood that it contains niobium as well as tantalum, but that the latter is present in preponderating amount, and *vice versa*.

The following are some of the heavy minerals which, in mode of occurrence, appearance, and physical characters, closely resemble tin ore, with which they are often associated. As the determination of these minerals requires a certain amount of knowledge and apparatus not usually available in the bush, it is advisable to forward samples to a qualified man to be tested.

TANTALITE.—Tantalate of iron, $FeTa\ O_6$. Part of the tantalum is invariably replaced by niobium, and part of the iron by manganese. The variety Manganotantalite contains more manganese than iron. Tantalic oxide, 43 to 86 per cent. Crystallised or massive, or in rolled ains. Black, opaque. Hard (6), brittle, G., 6.2 to 8.0.

STIBIOTANTALITE.—Tantalate and niobate of antimony, $Sb_2 (Ta\ Nb)_2 O_8$. Tantalic oxide, 40 to 55 per cent, Crystallised or massive, or in rolled grains. Grey, yellow, or brown; semi-translucent to opaque. Soft (5), brittle. G., 6.4 to 7.5.

MICROLITE.—Tantalate and niobate of calcium, $Ca_2 (Ta\ Nb)_2 O_7$ Tantalic oxide, 60 to 75 per cent. Crystallised or massive, or in rolled grains. Grey, pink, yellow, or brown; transparent to opaque. Hard (5.5), brittle, but much tougher than other tantalum ores. G., 5.2 to 5.7.

TANTALITE and STIBIOTANTALITE.—These ores of tantalum are of sufficient interest to warrant more extended notice. The following account of their occurrence at Greenbushes is taken from Bulletin No. 30 :—

> "The first discovery of tantalum ore in Australia was that of stibiotantalite in stream tin ore from Greenbushes by Messrs. J. J. East and G. A. Goyder, of Adelaide, in 1893. This mineral had previously been looked upon by the miners as either 'resin tin' or scheelite. This mineral threatened at that time to seriously depreciate the value of the Greenbushes tin, owing to its causing a contamination of the latter with antimony.
>
> "In 1900, at the time when the author (E.S.S.) was examining some of the antimonial tin ores, with a view to suggesting a method of treatment, trouble was again experienced at Greenbushes with a second class of concentrates. Some apparently clean tin concentrates from alluvial ground refused to yield up any tin, either in the assay pot or in the smelting furnace. Several samples of this mysterious ore were forwarded to the author, and proved to be tantalite of the normal iron variety.

"Two ores of tantalum, tantalite and stibiotantalite, have been worked on this field. Analyses of these are given below :—

	A. [2025]	B.	C.
Ta_2O_5 ...	80·61	51·13	51·95
Nb_2O_5 ...	2·50	7·86	4·49
SnO_2 ...	1·51	...	...
TiO_2 ...	·71	...	...
SiO_2 ...	...	...	3·14
WO_3 ...	·13	...	...
H_2O combined	·14	...	·61
FeO ...	10·89	...	...
Fe_2O_3 ...	...	trace	·39
MnO ...	3·78	..	trace
NiO ...	·02	·08	trace
CuO ...	..	...	·20
CaO ...	*Nil*	...	...
MgO ...	·19	...	..
Bb_2O_3 ...	*Nil*	40·23	38·04
Si_2O_3 ...	*Nil*	·82	·79
$(CeY)_2O_3$ ...	*Nil*	...	...
	100·48	99·82	99·61
Sp. gr. ...	7·74	7·37	6·47
Analyst ...	E. S. Simpson	G. A. Goyder	G. A. Goyder

"Neither of these minerals is by any means common on the fields, to the southern half of which their occurrence is limited. Of the two, tantalite is by far the most plentiful. Tantalite has been found *in situ* in Bunbury Gully, and at the head of the Moulton Brook (Battler's Gully) in a highly micaceous material (6506, 6375) which is probably the upper portion of an albite pegmatite of the usual type. In these it occurs in comparatively coarse and very fine pieces, devoid of all crystal faces, but exhibiting an ill-defined cleavage. Chiefly, however, it is known as waterworn pieces from the size of fine shot up to 13lbs. in weight (1927) associated with tin ore in the alluvial deposits of Bunbury and Floyd's Gullies.

"Associated with the stream tantalite, but in much smaller and less frequent pieces, is the unique mineral stibiotantalite. It is found at times forming thin veins in tantalite, of which it appears to be an alteration product due to the passage of antimonial solutions through cracks in the parent mineral. It occurs also in waterworn fragments from the size of a pin's head up to about two inches in diameter. Most of these consist of pure yellow or greyish stibiotantalite, but some consist of an ill-defined black core of tantalite surrounded by the pale coloured antimony mineral It always exhibits more or less definite traces of crystalline structure, one cleavage being usually very distinct.

> "The recorded output of tantalum ore is very small, viz., 2.46 tons up to the end of 1906. This, however, is probably very far short of the true total of ore raised, many comparatively small parcels of ore never having been reported to the Statist.

ENTERPRISE, M.L. 369 (14¾ acres).—This lease is situated at the head of Bunbury Gully, extending across the main road to Bridgetown. Mr. Campbell, in December 1905, described this mine in the following terms*:—

> "An opencut about 12ft. deep has been made on the west side of the road; the upper seven feet shows a wash of tin and tantalite (6507, 6508, 6509); below this is kaolinised gneiss, containing a micaceous lode formation (crushed pegmatite E.S.S.), 18 inches wide (6506), slightly greenish in tint, but in places slightly ferruginous, carrying particles of tantalite and tourmaline from coarse dust to chunks one inch in diameter. A drive has been put in on the lode 30ft. The lode is seen for 18ft., when it tapers out, but the micaceous formation continues and appears to be making again at the end of the drive. The strike of the lode is 323 degrees, and the underlay 22 degrees to the south-west. A shaft about seven feet deep has been commenced a few yards farther south to reach this lode further on the underlay. A pot-hole, one and a half chains north-west of the last spot shows a somewhat similar wash (6508)."

Some large pebbles of alluvial tantalite (6507) from this mine are wholly or partially covered with a smooth, hard, and firmly adherent coating of ferruginous bauxite, as much as three or four millimetres thick in places. This peculiarity is shared by the tin ore in other parts of the field. A fair amount of stibiotantalite has been obtained from this mine (7199).

Mr. Campbell further states:-**

> "A little tantalite is said to have been found in wash with tin on the next lease to the north, M.L. 370, Wills, held by Alfred Seabrook, and a claim, No. 755, the Dill-McKay, held by Messrs. Hille & O'Farrell, adjoining the east side of M.L. 369; and also in M.L. 379, Galtee-more, held by Messrs. Marsh and Galt; this is one mile south-westerly from the Greenbushes Well Reserve 1381; it adjoins part of the south side of M.L. 313, Battlers' Hope. A lode said to carry tantalite as well as tin has been opened up on this lease. It is a kaolinised pegmatite (6375)."

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* Western Australia. Report of the Department of Mines for the Year 1905. Perth: By Authority, 1906. ** Loc. cit.

GEOLOGY.

In studying the geological characters of this tract of country one is handicapped, as in all the South Western portions of this State, by the ubiquitous laterite cappings, which not only cover all the elevations, thus masking from observation the character of the rocks, but also overlay the deep leads and often even the alluvium of the gullies. It follows as a natural consequence that until this crust has been penetrated the actual character of the underlying rocks can only be surmised, and therefore no definite boundaries can be laid down. It is true that near the base of the hillsides and fringing the alluvium of some of the deeper gullies, and sometimes even in their beds, outcrops of gneissic granite with diorite dykes are exposed, which lead to the conclusion that the whole of this belt of country was composed of rocks of the acidic type, intersected by stanniferous greisen, but this has not proved to be the case, since wherever sinking has been undertaken upon the tin-bearing belt, the country rock has proved to be of a basic character.

This fact is supported by the composition of the superincumbent laterites which, from their richness in iron along this central belt, clearly indicate their basic origin.

CRYSTALLINE SERIES.—The oldest rocks exposed in this district, to which no age can be assigned, belong to this group ; they consist for the most part of gneissic granites intersected by bronzite-diabase and pegmatite veins ; later developments, however, have proved the existence of a belt of basic rocks beneath the laterites following the main tin-bearing zone of the field.

GNEISSES.—These rocks comprise by far the largest area, so far as can be observed, since they are seen outcropping along the gully sides or in their beds from the edge of the stanniferous belt to the boundaries of the field.

They are in places intersected by diabase dykes, pegmatite veins and quartz reefs often heavily charged with tourmaline, and apparently constitute the oldest portion of the crystalline series upon this field, but whether they are of sedimentary or igneous origin it is impossible to state.

These gneisses in places merge into dark-coloured mica schists, in which the mica is usually biotite, which gives the rock a black appearance, whilst the tourmaline quartz reefs pass into schorl rock.

Tin in small quantities has been worked in this gneissic zone in the vicinity of pegmatite dykes, or at points where it has been transported by the stream action, otherwise they do not appear to be metalliferous.

GREENSTONES.—Beneath the laterite which covers the central ridges of this field, striking in a north-westerly direction, a series of basic rocks are met with in sinking. These for the most part, so far as exposed, consist of highly weathered hornblende rocks and mica schists, which, in the section exhibited in Mr. Elias's tunnel, appear to be traversed along their foliation by a series of diabasic dykes, these dykes are sometimes massive bronzite-diabase extending upwards into soft altered country, but at others they are represented by a series of solid massive boulders, whilst, in a further stage of decomposition they appear as a chain of rounded and much weathered boulders.

It is impossible to determine at the present what class of rock these weathered basic rocks represent, but it is possible that they are diabasic, the foliation, weathering and disintegration being due to shearing and the subsequent passage of meteoric water with accompanying hydration.

At other points of this belt highly micaceous hornblende schists are also encountered, but these usually occur in the proximity of dykes.

DYKES.—Included within the limits of this greenstone area are belts of highly foliated granite, which are often of very considerable breadth ; they have not up to the present been penetrated beneath the zone of hydration, and in consequence they usually consist of kaolin with quartz and a little mica with, in places, bands containing large quantities of tourmaline and small quantities of cassiterite, the whole being intersected or traversed by small stanniferous pegmatite veins.

These pegmatite dykes which constitute the tin matrix, like the foliated granites, have not as yet been sunk upon into the unaltered rock, and, as a consequence, only weathered minerals can be examined, but, since they are the only members of this series which have so far proved to be of economic value, very considerable interest attaches to them.

They evidently represent the most recent of the crystalline series, for although they appear in places to have been cut through by the disbase dykes, it will probably be found upon more careful investigation that their fissures have only been suddenly deflected upon encountering these bars of hard massive rock.

Generally speaking, they consist of albite (felspar), muscovite or lepidolite (mica) and quartz, but the proportions in which these mineral constituents vary is so considerable that the veins in places may consist almost entirely of felspar or in others of quartz, whilst at others largely of mica or two or more of them in any proportion with such associated minerals as tourmaline, topaz, arsenical pyrites, cassiterite, stibio- and ferro-tantalite, zircon, ilmenite and gold.

Of these only the tourmaline plays any important part as a rock-forming mineral, and it is sometimes by far the most conspicuous mineral in the vein, whilst at other times it may only appear as fine needle-like crystals or grain, sometimes being entirely absent.

The pegmatites of this field illustrate most clearly metosomatic action, and with a little trouble a complete series of rocks could be collected illustrative of the gradual transition from a pegmatite, composed mostly of albite, through the greisen into a pure quartz specimen, which, when examined microscopically, still exhibits the granite structure, whilst tourmaline and cassiterite are the only associated minerals which have so far been found to exist throughout the entire series.

LODES.—Under this head are classed the pegmatite, greisen and quartz veins which carry cassiterite in appreciable quantities, they are met with along a greenstone belt which follows a course a little west of north, starting from a point about one mile from the south-east corner of this field, and extending northward for a distance of four miles, or, roughly speaking, to the north side of Dumpling Gully, with an average width of about two miles if a few minor outlying patches in the granite area are not included.

They may be divided into three groups, viz., the Foliated Granites, the Pegmatites and the Quartz Veins; the first two of these being distinct, whilst the last mentioned are in all probability only metosomatic alterations of the pegmatite dykes.

The foliated granites are of the least importance from a lode-mining point of view, but at the same time they have played an important part in the enrichment of the alluvium, owing to the fact that the denudation of these large low grade bodies after long periods of stream concentration have yielded rich deposits of fine grained tin ore, besides which these bodies are also often intersected by small veins of pegmatite rich in tin, or networks of these (stockworks), portions of which in the zone of weathering have been worked on alluvial ground near North Greenbushes.

The pegmatite dykes are roughly of three types, 1st, those which are largely composed of white felspar; 2nd, those of a red colour (ferruginous) and heavily charged with tourmaline; and 3rd, those of a highly micaceous character. The first of these are well illustrated in the South Cornwall, where a large dyke has been worked in the soft ground for a considerable length. The second class are more common at the Bunbury end, carrying tin in large crystals, the red colour being in all probability due to the decomposition of arsenical pyrites which has caused chemical reaction to take place upon the tourmaline, which, although occurring in large crystals, is usually soft and friable, whilst the cassiterite crystals are usually dull and etched upon thin surfaces.

At the surface these veins are very erratic in their behaviour, it being impossible to trace them individually for any length horizontally, but since they follow well-defined belts of considerable extent, it is probable that they are offshoots from a main body which exists at a depth.

The mica lodes (greisen) are particularly well developed in the Cornwall mine, upon which property one out of a series of three or four dykes has been worked for a length of several chains.

The quartz or quartz tourmaline veins (altered pegmatite) sometimes contain crystals of mica and cassiterite, One of these has been met with at South Greenbushes not far from the State Battery, and another to the westwar of Hester's troughs, but nowhere, so far, have they been proved to be of sufficient value to be worked profitably.

Besides these definite veins, large tracts of sandy country of considerable depth, carrying tin and tourmaline in the form of minute grains throughout, are met with in one or two localities in close proximity to a network of quartz veins, which appear to represent altered tin-bearing pegmatites (stockworks).

Although differing so greatly in appearance there is little doubt but that all of these dykes have a common origin, whether it be due to igneous intrusions into superheated rock, or to deep-seated hydrothermal action, is of little consequence from an economic point of view, since whichever theory is adopted, their source being deep-seated, it is probable that the small and more numerous openings at the surface will unite at a depth into main fissures of greater size. There is no good reason to fear a decrease in value, since not only were these fissures undoubtedly filled from below, but, owing to the insolubility of cassiterite no leached or zones of secondary enrichment need be expected in the upper levels similar to those met with in lodes carrying ores of other metals, therefore everything points to a continuance of the average values downwards, with possibly an increasing size of the ore body if the smaller veins unite.

LATERITES.—This formation, as will be seen from the map, covers a very considerable area upon this field, not only hiding from view the geological features of the country, but protecting in a large measure the stanniferous deposits from the denuding action of the streams.

They are distinctly the result of rock weathering *in situ* since not only may the character of the latter be determined by their composition, but the caps of lodes traced by the tourmaline and tin which still remains unaltered. Although the formation of laterites is supposed to be due to the weathering of rocks under a tropical and arid climate, we find in this State that they attain their maximum development in the South-West, which does not fulfil these conditions, neither are there any indications of it having been so during recent times, added to which the hilly character of the surface may be considered to constitute conditions utterly unfavourable to deposits of this class ; the natural conclusion is, therefore, that the climate has changed materially since the beds were formed, which assumption is supported by the evidence afforded by the deep leads, which will be dealt with later on.

One very remarkable feature with regard to these deposits upon this field is their occurrence, not only as the result of the alteration of the Crystalline Series, but also of the older and sometimes apparently the more modern alluviums, whilst it is not unusual to find beds of this material with alluvium both above and below them, thus clearly indicating periodic and zonal changes in the climatic conditions.

The laterite deposits are of economic value, other than road-making, for not only have they yielded large quantities of tin oxide in the proximity of lodes or stockworks, but at one point a quarry has been opened and worked for ironstone flux for the Fremantle Smelting Works, 7,481 tons having been raised, valued at £4,629.

These deposits vary in composition from solid and pure limonites to aluminous rocks almost destitute of iron ; they are often of very considerable thickness, giving great trouble to the miners, since they are so tough that explosives have but little effect upon them, as a consequence they have to be penetrated by picks, hammers, and gads. In their detrital form these laterites form what are usually known as ironstone gravel, these consist of nodular clay ironstones of concretionary appearance, either intermixed with sand or earthy matter, the latter being most common upon the greenstone area and the former upon the granites. They have been extensively worked in places for tin, being treated as alluvial deposits, and the tin separated for the most part by ground sluicing upon a fairly large scale on account of their generally low value. This class of stanniferous gravels is directly derived from the disintegration of lateritic deposits resulting from the alteration of tin-bearing lodes and stockworks *in situ*.

The only other economic purpose to which these gravels are applied is road making, in which those of the more clayey nature are preferable, owing to their better binding character.

There are also certain sandy deposits upon this field, which, although not strictly speaking laterites, still represent the weathering *in situ* of rocks destitute of both iron and alumina, therefore, although formed under precisely the same conditions, they lack cementation, no soluble binding material existed in them which could be drawn to the surface by capillary action.

These deposits are of certain economic importance, since they often contain fine grains of tin in small quantities through the entire mass. Work was started upon certain of them upon an extensive scale just at the time when the value of tin ore fell, after which they could not be looked upon as payable, and in consequence work was discontinued, but it will doubtless be resumed at some future time when the price improves.

These sand deposits are often of considerable thickness and usually contain a large volume of water, the sand, which is very fine and uniform in grade, often carries a small quantity of fine grains of tourmaline as well as cassiterite throughout the entire mass.

They evidently result from the weathering *in situ* of low grade stanniferous granites or stockworks, since no concentration has taken place, the tin being in as large quantities at the surface as below. In the vicinity of these deposits, where the surface is not entirely covered with laterite, large quantities of small quartz fragments are sometimes met with, these are of that brecciated character which may be taken to indicate their pegmatitic origin, the only contained mineral apparent being a little tourmaline.

As these fragments are usually sub-angular or flakey in character, they in all probability result from the disintegration of a network of veins of small size, and represent the intermediate stage of decomposition between the solid rock and the sand deposits.

ALLUVIUM.—These deposits are responsible for by far the greater proportion of the tin that has so far been won from this field, and may be divided into two main groups, the first of which, or most ancient, being the old river courses or deep leads, whilst the second are represented by the existing water channels. These latter must be for the most part of considerable antiquity, since the tin-bearing gravels are not usually met with at the surface, but lie at a depth of from 10 to 40 feet beneath the present stream bottom.

The deep leads represent the old drainage channels of the field, whilst the character of the deposits contained clearly indicate very different meteoric conditions to those prevailing at the present, since large deposits of shingle and boulders of considerable size have been transported by the stream for considerable distances. There is nothing to indicate any very material difference in the main points of the surface configuration, i.e., it would appear that the present highest point of the field was also the highest during the period that these creeks flowed, but the course they followed, although radiating from it and varying considerably from those of the existing watercourses, are apparently draining in the same direction towards the Blackwood River. It is quite possible, however, that the entire tract of country was much more elevated than at present and probably snow-capped during a portion of the year, which would cause heavy freshets after a thaw, thus accounting for the scour which has carried shingle and boulders for considerable distances. The exact course of these old streams is not quite clear, although a considerable time has been occupied in tracing them ; this is due to two causes, the first being that usually met with in similar cases, viz., recent denudation due to more modern streams having either intersected the older ones or obliterated all traces of them, often for considerable distances ; and the second, and that which gives the greater trouble, being the laterites which conceal considerable areas of these leads, thus necessitating a most careful inspection around the base of the entire sheet of capping in order to determine where the lead again emerges. This work would be absolutely impossible without an accurate topographical survey.

The description of these leads will be taken in the same order as the gullies to be mentioned later on, i.e., starting from the north with what will be described as the NORTHERN LEAD, which appears to take its rise eastward of the town at a point a little above the head of the New Zealand Gully, and travels in a north-westerly direction along the present course of that gully to Dumpling Gully, from which point it runs in a westerly direction upon the south side of the present watercourse, crossing the main road a little south of the Government Battery. After crossing the road it appears to take a sharp turn to the southward, passing beneath the Recreation Ground, thence south-westerly through Locations 290 and 289 and then south to Spring Gully, which it crosses travelling in a south-easterly direction upon the western side of F
Bark Swamp to the head of Battler's Gully (Mov

Creek), at which point it junctions with the Southern lead.

The NORTHERN LEAD has one main tributary, which may be called the CENTRAL LEAD, which takes its rise at the north end of the town upon a spur on the south side of Dumpling Gully, crossing the main road just outside the town boundary, and running in a southerly direction to head of Spring Gully, which it crosses and follows its western bank, then turns sharply to the southward, crossing the gully and the road, passing beneath a laterite spur into Paper Bark Swamp, and so on to its junction with the Northern Lead.

The EASTERN LEAD in all probability rises somewhere about the head of Scandinavian Gully (which falls from the eastern side of the town hill), from this point it passed in a southerly direction, crossing Floyd's Gully, and so on upon the eastern side of the hills to the head of Kelly's Flat, from which point its course trends to the south-westward, crossing the Bunbury Gully and junctions with the Greenbushes Lead at the Bunbury Hole.

The GREENBUSHES LEAD takes its rise at the head of Floyd's Gully, and flows in a southerly direction along the western side of the Bunbury Gully and, as before stated, unites with the Eastern Lead in the old Bunbury lease, from which point the channel sweeps first north-westerly through Elliott's old claim, then westerly to Cowan's Brook at a point called the Three C.'s, where it is joined by the Southern Lead.

The SOUTHERN LEAD appears to have two branches, one of which flows in a northerly direction from the southern boundary of the tin field, and the other which flows in a westerly direction from the Bunbury Gully along the course now followed by the Westralia Gully past Hester's Troughs, westward of which the two branches junction beneath an extensive flat, from which they appear to flow in a north-westerly direction beneath Poverty Flat, to the Three C.'s, when they join the Greenbushes-Eastern Lead, from which point the combined streams assume a northerly course to the head of Battler's Gully, where they unite in the deep ground beneath the laterite ridges with the Northern and Central Leads.

From this point the main channel apparently follows a south-westerly course upon the northern side of Moulton's Brook (Battler's Gully) to its junction with Cowan's Brook, which it first crosses on the south bank, and then turns back into the main channel, from which point it appears to have been completely swept away by the present creek for a distance of about half a mile, where it again appears upon the southern bank, which it follows to the junction of this gully with Norilup Brook.

It then passes through the hill point at their junction and suddenly turns north, following up the course of this Brook upon the western side to its junction with the West Brook, up which it turns to the westward and passes out of the field beneath a laterite ridge, to reappear again in the valley upon the other side, eventually discharging itself into the Blackwood valley.

These leads are not stanniferous through their whole length, the tin being entirely confined to those sections in which these old watercourses have traversed tin-bearing granite, it therefore follows that the GREENBUSHES LEAD, which follows the strike of a series of rich stanniferous pegmatites carries persistently good values for a considerable distance, whilst other leads which cross the strike of these rocks, although extremely rich in patches, contain sections of practically barren ground.

The gutters of the NORTHERN, CENTRAL and EASTERN LEADS are not as a rule very deep below the surface, whilst, owing to the fact that they are comparatively free from water, their extent and value is practically known, the only sections not thoroughly prospected are situated, 1st, at the crossing of Dumpling Gully by the main road and the Recreation Ground upon its western side, and, 2nd, at Paper Bark Swamp upon the southern side of Spring Gully. The first of these is due to the combined facts that a large quantity of water is met with at a shallow depth, that a large number of residential areas have been held since the early days of the field, and that the sports reserve cannot be touched, whilst the second is solely due to the water difficulty. Of these the Dumpling Gully Road Crossing and the Recreation Reserve sections may possibly be rich, as they are situated at the north end of the main stanniferous belt, whilst that of Paper Bark Swamp affords greater promise as a large low grade deposit, but may be rich if it is found that the stanniferous granites which enriched Spring Gully extend in that direction. It is known, however, in places to carry tin in small quantities throughout the sand from the grass roots down to the water level.

The richest portions of the NORTHERN LEAD are situated first at the upper part of Dumpling Gully, now being dredged by Mr. A. E. Morgans; this ground has been worked continuously from the early days of the field, during which period it has been turned over several times, but since the work was carried out without system the dredge is still able to show a good return. This portion of the lead was always considered to be recent alluvium, as it followed the same course approximately as the existing stream, but since the two deposits are separated by a thick layer of solid laterite this does not appear to be the case.

Another rich patch occurs in Locations 289 and 290, whilst upon the north bank of Spring Gully a very rich patch of shallow ground has been worked, which represents all that remains of the lead at this point, the balance having been removed by the more modern stream which has here crossed it, cutting away the older and enriching itself from this secondary source.

The CENTRAL LEAD was particularly rich at the point where it crossed the main road and again in the shallow ground upon the northern side of Spring Gully.

The EASTERN LEAD is very intermittent in values, but the GREENBUSHES LEAD, upon the other hand, is very constant and well defined for a length of about one mile. At the junction of these two leads upon what was the old Bunbury lease, where Stinton made his first discovery of tin upon this field, is a large open cut about 15 feet in depth, from which a large body of rich free dirt was raised, but, owing to the large volume of water encountered beneath this, no prospecting has been done recently, a small shaft has been sunk and a hole bored down for a further distance of 6 feet, when a large volume of water was cut, which at the time of examination was, still overflowing. This clearly indicates that the lead had not been bottomed at this point, and since the upper sands proved to be so rich and this area is situated in the very heart of the stanniferous belt, it is probable that a phenomenally rich deposit will be met with when this gutter is bottomed.

Very rich deep ground extended westward from this point, but, although large boulders were met with in the wash, it still remains to be proved whether or not this is a true bottom.

The SOUTHERN LEAD has so far only been slightly prospected, owing to the sandy nature of the ground and the large volume of water met with, which causes the sand to run in as fast as the water is lowered. It also appears to be doubtful whether it is a true bottom from which the wash is being raised upon Poverty Flat; this could easily be tested by sinking, and since the present bottom carried tin, if a deeper run exists it may prove to be very rich.

At the Three C.'s upon Cowan's Brook the boulder wash similar to that met with in the Westralia Gully occurs, this also would point to a deeper run below the workings of Poverty Flat.

From the Three C.'s the lead passes under the sandy flat to the northward and under a laterite ridge, where it was cut at a depth of 96 feet 3 inches in two shafts, the surface level of which is 70 feet above the bottom of the gutter at the Three C.'s, thus allowing for a fall in a northerly direction between the two points of 25 feet.

From this point in a westerly direction the lead is of little interest from an economic point of view, but it is interesting to note that its final discharge was only discovered through a shaft being sunk in West Brook, which encountered a heavy wash and so large a volume of water at a depth of 60 feet that it had to be abandoned, thus proving conclusively the existence of a main stream bed beneath this now blind gully.

THE ALLUVIUM OF EXISTING GULLIES.—As mentioned above tin in payable quantities is rarely found in shallow alluvium of the recent water channels, but more generally in older gutters lying upon the bed rock at depths varying from 10 feet to as much as 40 feet beneath them, owing, however, to the fact that these follow the same drainage valleys they can only be classed as recent deposits.

The general character of these deposits at the heads of the gullies are alluvial flats, with a gradual fall traversed by a more or less defined creek bed ; lower down their courses, however, where the streams flow in deeper valleys, alluvial deposits are almost totally wanting, the stream bed often consisting of a series of rocky bars over which, during the rainy season, the water falls in a series of miniature cascades.

These streams, although they all apparently take their rise from the same central point as the deep leads, and discharge themselves eventually into the Blackwood Valley, follow a more circuitous route, and must therefore be divided into two series, the first, or northern, group being tributary of the Norilup Brook, which passes out of the field at the south-west corner, and the second those which feed Hester's Brook, which flows out at the south-eastern corner of the field. The first of these, which flows into Norlup Brook, are Boronia, New Zealand, Dumpling, Gibney's and Spring Gullies, Cowan's and Moulton's Brooks (Battler's Gully), whilst into Hester's Brook flow Salt Water Gully, with its branches Scandinavian Gully, Floyd's Gully and Kelly's Flat, also the Bunbury Gully, with its branch the Westralia Gully. There are also a number of gullies which rise upon the north and north-eastern side of the Railway line, but since these are not stanniferous a description of them will be omitted.

Boronia Gully is the most northerly branch of Norilup Brook, and drains all the northern portion of the field south of the Main Road, but, with the exception of one sandy patch at the junction of two of its branches, it has not proved so far to be tin-bearing.

BORONIA, M.L. 361 (20 acres).—This lease is situated at a considerable distance from any other mine, except Claim 727 which adjoins it. It lies about 1½ miles north-west of Loc. 289. Its output has been :—

To end of 1905 ...	5.05 tons ...	£406
1906 ...	6.37 ,, ...	638
1907 ...	5.45 ,, ...	514
Total ..	16.87 tons	£1,558

DUMPLING GULLY AND ITS TRIBUTARIES.

Dumpling Gully, with which may be included its main tributary, New Zealand Gully, rises at a point to the north-eastward of the town at an elevation of 980 feet above the sea level, and after a westerly course of about a couple of miles it trends gradually to the southward, when it is joined by Spring Gully and its tributaries, after which the watercourse is then known as Norilup Brook.

At its head Dumpling Gully spreads out into sandy flats or swamps of considerable extent, and receives several tributaries from the north. After crossing the main road these flow over crystalline rocks in a narrow valley, the sides of which are formed by the extensive deposit of ferruginous conglomerate.

> * "About three chains west of the Railway Station are a series of tin workings on the eastern face of a gentle slope, which dips gradually in the direction of Dumpling Gully. The section shows about two or three feet of conglomerate passing almost insensibly into sand, which in its turn gradually gives place to granite. The granite sand yielded good prospects of very angular tin (1281), which must have had a local origin.
>
> "About three chains to the south of this is a vertical shaft, 15 feet in depth, showing the following section :—Conglomerate five feet, passing insensibly into sand (wash ?) of five feet in thickness, succeeded by a clay, into which the sand gradually passes, without any well-defined line of demarcation. A fair prospect of somewhat angular tin was obtained from the sand (wash ?).
>
> "On what was originally M.L. 82/519 two vertical shafts, 10 feet in depth, expose about five feet of conglomerate, which passes gradually into a coarse micaceous rock which carries sharp angular tin.
>
> "About ten chains due south of the last-named locality three vertical shafts of unknown depth bottomed on cement, beneath which was eight feet of sand (decomposed granite) carrying very ragged tin."

At the head of the New Zealand Gully is the old Olympia, M.L. 48, which was worked in the years 1899 and 1900 when it yielded 1.20 tons of black tin valued at £101. It

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* A. Gibb Maitland, Govt. Geologist. Annual Report Geol. Surv. Dept., 1899.

had been worked previously, but since no official record of production was kept until 1899 it is impossible to estimate what this area yielded, whilst since 1900 it has been held as claims of which no notice can be taken here on account of the labour involved.

Lower down the gully is the lease which gives its name to it, this has since been held under various registered names. **Output** :—

1899	New Zealand, M.L. 17 ...	.80 tons	£50
1901	Caledonia Co., M.L. 156	2.26 ,,	127
1902	Do. do.	10.00 ,,	558
1903	(Ivy) Lady Esther Leases M.L. (330) 331	7.00 ,,	532
1905	Do. do. ...	3.00 ,,	212

(Returns now included in the Greenbushes Development Company, Ltd.)

The following leases are situated in Dumpling Gully :—

HORAN'S M.L. 35 (12 acres) and M.L. 169 (20 acres), HORAN'S No. 1 NORTH (15 acres).—These are now held by the Greenbushes Development Company, together with a large number of other leases. They were previously owned by the Westralian Stanneries, and still earlier were independently held. Previous to 1905, M.L. 35 produced 188.35 tons of dressed ore, valued at £11,605.

W.A. Mt. BISCHOFF M.L. 218 (20 acres).—This lies immediately south of the North Greenbushes township. Specimens of ore (688, 689) from this lease consist of a hard ferruginous conglomerate carrying a considerable amount of fine and coarse sub-angular tinstone. A third specimen (690) appears to be a much weathered granitic rock carrying a little coarse angular tin ore.

Previous to 1905 this lease yielded 5.38 tons of black tin, valued at £342. Since that date it has been held by the Westralian Stanneries and the Greenbushes Development Company, and the returns lumped with those from other leases. (See below.)

GLASGOW M.L. 375 (20 acres), lies a little north of Greenbushes township, and covers part of the ground held

PHOTO 1.

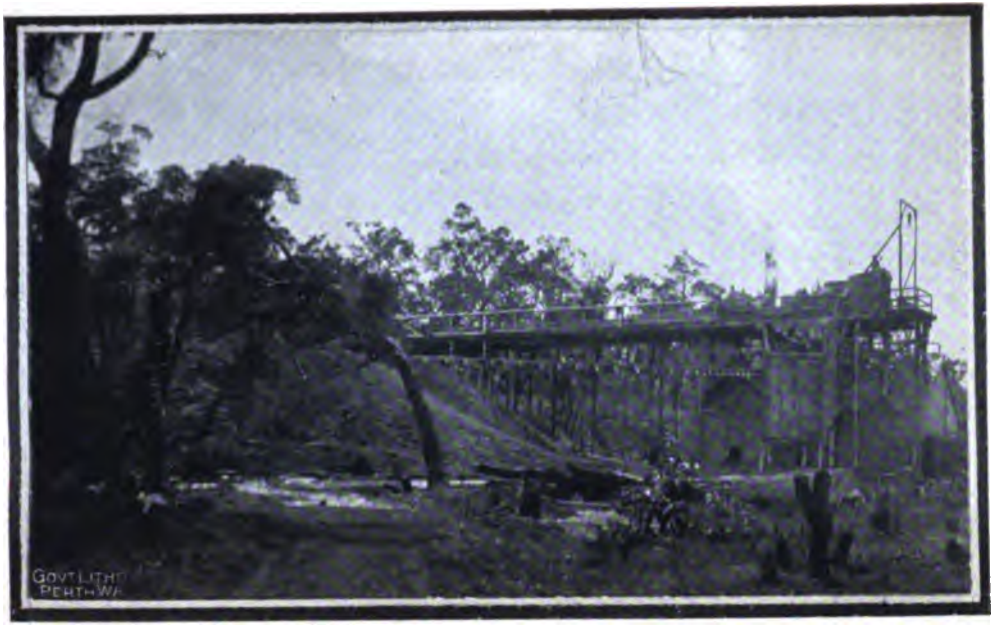

Photo by H. P. Woodward.

HYDRAULIC SLUICING PLANT.

previously as M.L.'s 75 and 112. A lode said to be 5ft. wide has been sunk on to a little depth. Of two specimens of lode stuff presented by Warden Geary to the Museum in 1905, one (6517) from near the surface, is a pegmatite composed mainly of albite with tourmaline, quartz, muscovite, garnet, and a considerable percentage of tin ore ; the other (6518) from a depth of 30 feet is a quartz-tourmaline rock with but little tin. Some very angular ore (2019) collected in 1900 assayed 66.3 per cent. metallic tin. This lease has been reported to yield up to the end of October, 1906, when it became part of the Greenbushes Development Company's property, 1.54 tons of tinstone, valued at £150. Of this, 1.39 tons were obtained from 206 tons of lode stuff.

THE GREENBUSHES DEVELOPMENT CO., LTD.—This company has now secured a large area in this locality, which includes most of the previously mentioned and several others.

It is being worked by a hydraulic dredge, the whole surface down to the bed rock being washed down by means of water played upon it from a nozzle, whilst the material thus disintegrated is elevated to the sluice boxes which are placed upon the top of the dredge, by means of suction exercised by centrifugal pumps ; the hopperings and cement masses being carted to the battery, where they are crushed in Krupp Ball mills, the tin being saved upon concentrating tables.

The main valley consists of a large alluvial flat, but a few feet beneath the surface a solid bed of ferruginous cement (laterite) is encountered, which rests directly upon a kaolin wash some 3 or 4 feet in thickness.

Some of the richest portions of this wash were worked in the earliest days of the field by means of opencuts, the water being drained from the excavation by long deep channels, whilst the soil and cement were stripped and the wash filled into drays and carted to puddlers. Later on, when the large leases were abandoned, it was taken up as a number of small holdings, when the wash was mostly mined, but, owing to the creepy nature of the bottom, this was not only unsatisfactory but dangerous.

More recently the majority of these leases were secured by the W.A. Stanneries Ltd., an English company who continued work upon the primitive lines adopted generally upon this field, but in spite of this they won a considerable quantity of ore. It then passed into the hands of the present company, who equipped it with a Pontoon dredge, a Krupp mill and tables, whilst a water supply was obtained by pumping from the Blackwood River, some five miles distant.

It is quite impossible to estimate the quantity of tin won from this gully, but it may be quite safely assumed that it exceeded 1,200 tons which at £70 per ton would be worth about £84,000.

This area, although continuously worked ever since the discovery of the field, is by no means exhausted, owing to the fact that during the time it was held under small holdings the value of tin was so low that only the very richest portions of the wash paid to work by the primitive methods employed ; added to this so much was lost on account of the treacherous nature of the ground.

The present method of hydraulic sluicing by the face makes a clean sweep of everything, the profits being made out of those rich patches either missed or lost by the original holders, whilst the lower value ground previously unworked is also payable when treated upon this large scale.

The tin in the deposit worked upon this area appears to have originated from the disintegration and denudation of stockworks, portions of which have been worked at a point near the Railway Station. These, owing to their highly weathered character, were supposed to be alluvial deposits, but a careful examination reveals the fact that within the kaolin mass small veins or strings of quartz fragments can be traced intersecting it in a more or less vertical direction.

In this class of formation the tin occurs in a highly crystalline form of a brilliant black, amongst which some most perfect octahedrons have been met with, whilst the tin from the true wash, although coarse and similar in character, is water worn.

As before stated, it is impossible to compute the total quantity of tin raised from this area prior to the year 1899, when the statistical register was first started of the production of the baser metals, whilst since that date only the production of the leases can be readily obtained, but even this demonstrates conclusively the richness of this tract of country.

Production of various leases	424.19 tons	£23,711
W.A. Stanneries Ltd.	109.33 ,,	8,171
Greenbushes Development Co., Ltd. ...	150.37 ,,	13,667
Total	683.89 tons	£45,549

LITTLE WONDER M.L. 470 (8 acres approx.).—Includes old alluvial claims 760 and 767, and is held by the Nickel-Kramer Tin Mining Co., Ltd. This company holds also M.L. 471 and has already, erected a considerable amount of crushing and concentrating machinery. The stanniferous material on M.L. 470 consists of wash and hard ironstone conglomerate. The output during 1906 was 8.36 tons of concentrates, valued at £900, whilst in 1907 it was 1.60 tons of ore valued at £95.

NORTH JUNCTION M.L. 394 (154) (20 acres).—Near the westerly corner of this, under 5ft. of laterite, two shafts exposed a coarse micaceous granite carrying tin. During 1906, this lease reported 0.05 tons of stream tin and 0.10 tons of lode tin, of a total value of £17, and previously .45 tons for £28, making a total of .55 tons worth £45.

GLADSTONE M.L. 337 (5 acres), is held in conjunction with Claim 706 (2 acres). It includes part of old M.L. 78, and adjoins the township on the north side. Output .—

To end of 1905 ...	24.13 tons	£1,912
1906 ...	8.08 ,,	821
Total	32.21 tons	£2,733

CENTRAL M.L. 296 (39¾ acres), is situated upon the Main Road at the northern boundary of the township, it has worked during the years 1905, 1906 and 1907, yielding 100.16 tons, worth £9,728.

The whole of the Dumpling Gully area is situated at the extreme north end of the main stanniferous belt, the bed rock is in many places simply riddled by small tin-bearing veins, quantities of which have been removed bodily when in a weathered state and treated as alluvium. The tin is of a brilliant black in most perfect octahedral crystals, assorted with small quantities of tourmaline and contained in a kaolinised granite showing a little mica in places; so far, however, no veins of sufficient value and size have been discovered to be profitably worked into the solid country.

OLD SPORT M.L. 400 (5 acres) adjoins the south-west corner of Recreation Reserve 2687. The output during 1906-7 was 1.50 tons of lode tin, valued at £150. In his original report on Greenbushes, the Government Geologist describes this locality as a sandy flat flanked by laterite rises, stanniferous granite much weathered being encountered at a depth of about 12ft.

From this point downward Dumpling Gully has so far proved to be barren in tin, which also lends colour to the suggestion that the portion first mentioned is all part of an old watercourse, the existing stream having in no instance come in contact with the stanniferous rocks but simply flowed over the valueless upper bed of the old rich lead.

> * "To the west of the main road, from Bridgetown to Donnybrook, a fairly well marked gully, heading in Location 290, enters Dumpling Gully from the south. Adjoining the northern boundary of this location, a series of shallow workings, only about 12 feet in depth, have bottomed on micaceous granite, traversed by thin quartz veins. At the bottom of the excavations, the rock is very friable, owing to decomposition, though it has lost neither its individuality nor its geological identity, the material gradually passes upward into sand, which finally gives place to soil forming the surface of the ground. This decomposed granite yields in places fairly coarse subangular tin, and titanic iron. So far as operations have at present been carried, the tin ore seems to be concentrated at the bottom of that portion of the deposit which has undergone most decomposition. On either side of the sandy flat which forms the watercourse, conglomerate of the usual type prevails, and in some cases it covers the wash (?) last mentioned. This conglomerate is in some cases stanniferous, which is only what would be expected, seeing that the formation beneath it is tin-bearing."

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* A. Gibb Maitland, Govt. Geologist. Annual Report Geol. Surv. Dept., 1899.

LOCS. 289, 290 (once Bishop Gibney's mine) occupies granitic and alluvial ground at the heads of two tributaries of Dumpling Gully. This property has been a most consistent producer from the earliest days of the field. In 1890 the most extensive workings on this property, and those from which the most tin was raised, were situated about the middle of the area on the south side of a swamp, where close to an ironstone ridge a gravelly wash carried about ½lb. of tin to the dish. Further into the swamp there was about 6ft. of sand, which carried about 1oz. of fine tin to the dish. Farther to the westward, in a little gully, a gutter about 15ft. wide was worked by a series of shafts and drives. In the sinking there was from 5ft. to 6ft. of gravel cemented above the wash, which was here from 1ft. to 1ft. 6in. in thickness, often carrying pieces of ferruginous sandstone very rich in tin, the whole wash yielding close up to 1lb. to the dish. The rock underlying this ground is a coarse granite.

The total output credited to these two blocks by the Statist to the Mines Department is :—

To end of 1905	...	111.86 tons	£9,155
1906	...	108.75 ,,	11,110
1907	...	55.08 ,,	5,624
Total		275.69 tons	£25,859

This is no doubt considerably short of the real total owing to the fact that the statistics have only been kept in detail for a few years past.

> * "An important tributary (Gibney's Gully) rising in Location 289, enters Dumpling Gully about a mile and a quarter below Reserve 2687. The swampy flat at the head of the gully has yielded fair quantities of surface tin, derived no doubt from the underlying granite, which is exposed in the shallow shafts at the south-east corner of Location 289. About five chains west of the western boundary of Location 289, and near the south-east corner, a vertical shaft has been sunk to a depth of 20 feet, through granite of the prevailing type, but, so far as I am aware, no tin was obtained. Eight chains west from this a very shallow shaft has been sunk, through the conglomerate to the granite.
>
> "Down Gibney's Gully, the width of the alluvium in the valley is not very great, but forms a narrow strip on either side of the watercourse.

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* A. Gibb Maitland, Govt. Geologist. Annual Report Geol. Surv. Dept., 1899.

"At the junction of the gully with the main watercourse, Dumpling Gully, the country rock has changed and the granite is succeeded by vertical schistose rocks, which trend north-east and south-west. The schists are intersected by a dyke of garnetiferous pegmatite (1243).

"About 18 chains further down Dumpling Gully schistose rocks are exposed on both banks of the stream, they are inclined at a high angle to the west and trend generally north and south."

SPRING GULLY AND ITS TRIBUTARIES.

*"The head waters of Spring Gully take their rise at an altitude of about 930 feet above sea level and with the exception of three branches, two of which rise to the south of Bishop Gibney's Freeholds, and the other to the north of the Three C.'s Leases, flows generally to the westward, with a fall of about 200 feet to the mile.

"A great deal of work has been accomplished in Spring Gully, and more especially on the tributaries entering it from the north.

"An important branch, named Mulligan's Gully, takes its rise at the south-east corner of Location 289, and traverses granitic rocks and their debris for the whole of its length. Just on the north side of the gully, and adjoining the north-west corner of an old lease (Peg 82/264), a good deal of surface work has been carried out upon a decomposed granite. In places this granite is covered with a shallow coating of what may be called rain wash, formed by the disintegration of the underlying granite. This zone of decomposition is in places phenomenally rich in tin, and has been extensively worked in Mulligan's Gully, but the official figures, however, do not disclose the quantity of black tin raised from this gully.

"Close to the western boundary of an old abandoned lease (82/298), just below the outcrop of the ferruginous conglomerate, and on the eastern side of Mulligan's Gully, four shallow shafts have been put down, to depths varying from 8 to 30 feet, through a typical granite decomposing in the direction of kaolin. There is no record, however, of tin having been found in any quantity in these shafts.

"A good deal of surface work has been done in previous years on the ground traversed by Mulligan's Gully, and a fair quantity of tin seems to have been obtained. The tin-bearing granite, underlying the shallow surface deposits, is exposed in several of the old head races.

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* A. Gibb Maitland, Govt. Geologist, Annual Report Geol. Surv. Dept. 1898.

"At the head of the gully is an old lease (82/244.) A vertical shaft on Captain May's ground, 16 feet in depth, shows a 'tin floor' dipping at a low angle to the north-east. This floor had been followed, at the date of my visit, to the rise for a distance of about 30 feet to the south-east. The tin, which is associated with tourmaline, quartz, and a little mica, is confined to a zone of about one foot thick, met with at the bottom of the shaft. The tin-bearing matrix is a decomposed granite.

"A great many old workings are situated on the ground lying between Mulligan's Gully and the main head of Spring Gully, but by far the larger majority were inaccessible, but a few modern prospecting shafts enabled me to ascertain something of the nature of the deposits in the vicinity. The surface of the ground is covered with the ferruginous conglomerate which itself carries (as is only to be expected from its mode of origin) a certain quantity of tin, which, however, is not evenly distributed throughout, but seems to be concentrated in certain isolated patches.

"A shaft (Keleher's), 20 feet in vertical depth, was being sunk on an old lease (82/283) alongside the northern boundary of 82/237. The first five feet of sinking was through conglomerate, and thence through a decomposed granite, which at the bottom of the shaft was found to be traversed with small quartz veins.

"About two chains to the south of this a similar section is exposed in Love's shaft, which had attained a depth of 17 feet.

"Two and a half chains further south are two shafts on Sugar's ground. The northernmost shaft was about 16 feet in depth, and exposed little else than rain wash, which yielded very good prospects of tin. The southernmost shaft has been carried down to a vertical depth of 13 feet through rain wash and decomposed granite. Thin seams of tin occurred just where the granite appeared to be least decomposed.

"A shaft was being put down by Captain Keheler to the west of these last mentioned, on an old lease (82/256) with the object of intersecting one of those 'tin floors' which previous observations have shown to occur in the granite of this neighbourhood. The shaft had been carried down to a depth of 20 feet vertically below the surface, through a friable decomposed granitic rock. The 'wash' consists of subangular fragments of the constituents of the granite, and fragments of tourmaline crystals.

"In addition to the above a good deal of tin is being derived from a deposit formed in the existing valley of

Spring Gully. The deposit consists of two distinct portions :—

(a) An upper or "free dirt," i.e., loose gravel ; and

(b) A lower stiff "clayey dirt," containing irregular bands of detrital tin.

"The free dirt, which varied from one to three feet in thickness and about 18 to 20 yards in width, proved exceptionally rich in tin. Apparently the previous holders of the ground never touched the lower wash.

"This portion of Spring Gully has proved exceptionally rich, and no small portion of the stream tin has been derived from the denudation of the tin-bearing granite occurring in Location 289, and the ground to the south. From the fact that Spring Gully, just at the junction of Mulligan's Gully, traverses the southern continuation of this granitic belt, and has cut down into it to some considerable depth, it is not at all unreasonable to expect that a system of judicious prospecting would lead to the discovery of tin veins or lodes in the granite itself. The physical character of some of the tin shows that it can only have been realised from the parent rock, in close proximity to where it is at present found."

From this gully a very considerable quantity of tin ore has been taken, probably as much as a quarter of the total production of the field, but since there are absolutely no means available for accurately ascertaining the quantity won from this locality prior to 1899, whilst since that date until quite recently most of the stanniferous ground has been held as registered claims, the compilation of statistics with regard to the output from this area would be next to impossible.

Although extensive patches of very rich alluvial ground have been worked the primary deposits, whether lodes or stockworks, from which the tin has been derived, have not up to the present been discovered.

The stanniferous deposits of this valley are of two orders ; 1st, those of the older stream beds which at the present time are met with at a higher elevation than the recent alluvium, and are characterised by their cemented nature, whilst the 2nd, which are only met with in the existing gullies, appear to be derived directly from the denudation of the former, since it is only at and below those points where the older water channels appear t have crossed the existing valleys that patches of considerable enrichment occur.

The tin has a distinctly water-worn character, that i the modern stream bed being as a rule in finer grain than that in the older cemented wash, but it is all of high grade.

Like Dumpling Gully, this area has passed throug all the various stages, from large holdings in the earl days of the field to small holdings later on, but eventually when these became non-payable upon this scale, the were again absorbed in large leases upon which the was is being worked upon a larger scale, good, bad, and indifferent passing through the boxes, and in consequenc little of value will be left when the dredges have passe over the ground.

Besides the rich deposits before mentioned a very considerable extent of low grade sand appears to exten from the south side of this gully, which is called Pape Bark Swamp, this it was intended to sluice a short tim ago, but, owing to the sudden fall in the market value o tin, operations were suspended.

There are apparently two old stream beds which cros this valley, both of which have been worked and prove to be rich upon its northern bank, but so far they hav not been prospected to the southward, owing to the larg volume of water encountered in sinking and the lack o pumping appliances to cope with it ; now, however, a there is a very large quantity of this class of plant upo the field they could easily be tested.

Mt. PLEASANT M.L. 471 (40½ acres approx.).—Include old M.L. 244 and Claim 652. Held by the Nickel Krame Tin Mining Co., Ltd. The tin-bearing material consists c a wash and an ironstone conglomerate requiring crushing It has been worked on a small scale for many years b opencuts, and by means of 40 or 50 shafts, which reache bottom at from 15ft. to 30ft. The recorded output fro this ground is :—

To end of 1905,	M.L. 244	...	36.45 tons	...	£2,995
1906,	M.L. 244	...	7.85 ,,	...	801
1906,	Cl. 652	...	1.55 ,,	...	155
1907,	M.L. 244	...	2.92 ,,	...	266
	Total	... ...	48.77 ,,	...	£4,217

CLAIMS 608 (22 acres) and 700 (32½ acres).—These lie immediately below M.L. 471, occupying the head of the main channel of Spring Gully. Outputs :—

1906—Cl. 608	... ...	21·90 tons ...	£2,083
Cl. 700	... ...	58·35 „ ...	5,928

CLAIM 318 (28 acres approx.)„ known as the old Spring Gully, or Sinclair's Claim.—This is one of the oldest and most productive alluvial claims on the field. It occupies a narrow strip of the main gully for a length of ¾ mile. The deposit in. this claim consists of two distinct portions, an upper or "free dirt," and a lower, or "stiff clayey dirt." The former was loose and gravelly, being composed of fine and coarse quartz (694, 695) of a somewhat violet tinge, and granular structure very typical of Greenbushes. It was from one to three feet thick, about 18 to 20 yards wide, and proved exceptionally rich in tin. The latter consisted largely of a stiff white clay (1633) containing irregular bands of fine cassiterite associated with garnet, zircon, tourmaline, and gahnite (zinc spinel) in irregular grains and well-formed crystals of all shades of green (697). Occasional small pieces of metallic tin are found in the wash. These have probably been reduced from surface ore during bush fires. In 1890 the wash carried about 1lb. of tin in the dish, whilst in some places in the head of the gully very rich pockets of wash were met with from 6ft. to 10ft. in depth. Up to that date about 50 tons of tin had been sent away, and about as much more was expected from the dirt already raised, which would be washed out in the following winter. It was a wonderfully rich claim, and about the easiest to work on the whole field. This area is now being worked by a dredge, and is owned by Mr. Frank Moss. Mr. A. Gibb Maitland considers that a large proportion of the stream tin in this claim was derived from the tin-bearing granite about the head of Mulligan's Gully, this is quite possible, the tin being carried to Spring Gully by the deep lead which crossed it.

Of the actual output of this claim no complete record has been kept ; the following figures appear to be the only ones available :—

Previous to 1899 ...	40.00 tons ...	£1,600
1899	21.75 ,, ...	2,065
1900	No returns available.	
1901	7.85 tons ...	£386
1902	5.45 ,, ...	368
1903	14.82 ,, ...	1,041
1904	17.80 ,, ...	1,277
1905	30.95 ,, ...	2,736
1906	23.35 ,, ...	2,518
Total	161.97 tons ...	£11,991

CLAIM 758 (6 acres approx.) is situated in Mulligan's Gully. Output—1906, 0.40 tons, £43.

STANHOPE M.L. 387 (10 acres).—On lower end of south branch of Spring Gully, includes part of old M.L. 87, Sinclair's. Output—1906, 6.53 tons, £704.

M.L. 450, etc., now held by the Stanhope United Leases Spring Gully Dredge, embraces most of the ground originally held by Sinclair. This company, by the means of a dredging plant, have during the last year obtained 10.72 tons of tin ore from this creek bed, which was valued at £828, which brings the total up to over £27,000 worth of tin from this ground since 1899.

CLAIM 684 (4 acres approx.) is on the north end of Paper Bark Swamp.

In addition to the leases and claims mentioned above, the whole of the lower part of Spring Gully and the valley of Norilup Brook is held under lease or claim. From the latter the Norilup Tin Mining and Dredging Co., Ltd., obtained 2.13 tons of tin ore in 1908, valued at £151.

The old HOMEWARD BOUND and REDRUTHE leases which were situated upon the northern bank of Spring Gully close to the old Spring Gully claim, are recorded to have yielded 26.92 tons of tin from cement wash, which realised £1,899.

BUNBURY GULLY AND ITS TRIBUTARIES.

The Bunbury Gully rises at an elevation of 990 feet above the sea level upon the main Bridgetown Road at a distance of about 50 chains south-west from the town. It flows in a south-south-east direction, falling at the rate of about 200 feet to the mile. It was called the Bunbury Gully, and the south end of the field the Bunbury End, not because it was the end nearest to the town of that name, but owing to the fact that the original tin discovery made by Mr. Stinton is located here, which was first worked by the Bunbury Syndicate.

It has two main branches, which flow into it from the western side, the northernmost of which is called Elliott's Gully, and the southern the Westralia Gully.

Within this valley tin ore has been obtained from lodes, from deep leads, and from more or less shallow alluvium. The stream ore here is not so pure as in the valleys previously described, lodes and leads carrying tantalite and stibiotantalite having been located at the head of this valley, and these minerals contaminate all the dressed tin to a greater or less extent. Near the head of the valley a little water-worn gold has frequently been encountered in the tin concentrates.

> * "It is flanked on either side by the ironstone conglomerate, and where not concealed by alluvial deposits, the granitic rocks make their appearance beneath it.
>
> "The country will be best described by taking the sections exposed in the various claims in geographical order from north to south.
>
> "On the summit of the saddle which divides the waters of Bunbury Gully from those falling into Salt Water Creek, two shafts had been put down on Messrs. Brook & Barrat's claim. The depth of the shafts was about 10 feet ; the section in the shafts show first about two feet of ironstone conglomerate, succeeded by a cement composed of rounded and subangular pebbles, quartz, tourmaline, and other decomposed products of a granitic rock. The cement rests on a fairly defined clayey floor. The component pebbles of the cement do not possess those characters which point to their having been mechanically rounded by water ; the deposit would seem to be talus or cliff debris. The cement is tin-bearing, the ore being probably derived from the disintegration of the tin-bearing granite in the vicinity.
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> "At the actual head of Bunbury Gully, two other vertical shafts have been sunk to a depth of 11 feet vertically below the surface, on what is known as McDonald's claim.

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* A. Gibb Maitland, Govt. Geologist, Annual Report Geol. Survey Dept., 1899.

Both shafts penetrated a variable thickness of ferruginous conglomerate, which forms a superficial covering to the ground. The so-called wash is nothing but decomposed granite which yielded fair prospects of tin.

"The ground known as Giblet's lies just near the head of Bunbury Gully. The section in the main shaft shows about six feet of the ubiquitous conglomerate beneath which a decomposing granitic rock continues to the bottom of the shaft. At a depth of 14 feet from the surface is a band of rubble, containing partially rounded boulders and pebbles of tourmaline and quartz. This rubble or wash, which contains tin disseminated through it, rests, without any very distinct boundary, upon a clayey bottom, evidently granite decomposing *in situ*.

"Gold has been found associated with the tin, both by the previous and present holders of the ground.

"Several old workings exist upon the ground, but, owing to their inaccessibility, very little information in connection with them is available. An old shaft lying about 13 feet to the east of what is known as Selborne's old shaft, shows that the wash is only about three or four feet from the surface. The section in this and Giblet's shaft shows that the 'wash' is not a wash within the usual acceptation of the term, but would be best described by the term 'rain wash' rather than genuine alluvium. The deposit owes its preservation to being covered with a later formation.

"Adjoining the north-east corner of Reserve 1381, a shaft has been put down to a depth of about 12 feet. The sinking exposed four feet of modern alluvium, and the remainder a kaolinic rock with white mica and tourmaline ; the rock is evidently a decomposing granite. A few yards to the west, on the lower slopes of the valley, a nine-feet shaft encloses an ironstone rubble of about four feet in thickness, resting upon decomposing granite."

"HAMEL and SMITH'S CLAIM.—Some distance lower down Bunbury Gully, and on the southern wall of the valley, a series of shafts have been put down to varying depths. These shafts disclose the underground structure of the country. Two vertical shafts of about 30 feet in depth are connected underground.

"In the workings a well-marked 'tin floor' underlies a comparatively low angle to the west. The material forming the 'floor,' locally spoken of as 'wash,' is about 2ft. 6in. in thickness, and consists of mica, quartz, a little tourmaline and tin. The deposit in all probability represents the decomposed portion of one of those tin-bearing veins by which the granite is reticulated. The most southerly shaft on the claim, at a slightly lower altitude, has a depth of about 20 feet, and the 'wash' only one foot in thickness.

"Some little distance to the south seven other shafts have worked a similar deposit.

"On KRAMMER'S CLAIM a vertical shaft, 34 feet in depth, intersected a decomposed 'tin floor' of from three to four feet in thickness. This floor has a gradual dip to the south-west. The deposit ('wash') is very rich in tin, the ore being often rounded or subangular (1823). In that portion of the property which lies close to the bank of the gully, very sharp, bright, angular tin (1284) occurs at a very short distance below the surface. The ore must have been released from its parent source not far from where it is at present found.

"On the western bank of Bunbury Gully, and opposite Bench Mark XXIII., is a water shaft some 30 or 40 feet in depth. The shaft was inaccessible to me, but, judging from the material lying at grass, the sinking was through a very decomposed micaceous granite.

"Further to the south-west, and on the western bank of the gully, three shallow shafts have been put down. The most northerly of the three shafts, about 10 feet in vertical depth, showed a few feet of cement rubble, partially consolidated, succeeded by about three feet of 'wash' containing a high percentage of tourmaline. The most westerly of the group was about 20 feet in depth, and passed through no wash, but merely pierced a clayey decomposition product of a granite.

"On the eastern side of the main road to Bridgetown, on what was originally M.L. 82/76, a shaft has been put down to a shallow depth upon a tourmaline dyke, which was met with beneath the conglomerate at a depth of about five feet below the surface. The overlying conglomerate contains detrital tourmaline, which led to the discovery of the dyke. As exposed in the workings, the width of the dyke is about 2 feet 6 inches. The strike of the dyke is generally north-west, with an underlie to the south-west at angle of about 70 degrees. The tourmaline is enclosed in a ferruginous clayey matrix, which contains occasional patches of quartzose material. Evidently the dyke will prove to be one of the felsitic family. The dyke yielded a small quantity of very angular tin associated with large quantities of titanium. An assay of a sample (1376) yielded in the official laboratory 1.97 parts per hundred of metallic tin. The tourmaline carries a small proportion of tin. The dyke is known as the Amanda Lode.

"What is apparently a parallel lode is exposed some little distance to the north, on what was known as PARICH & ARMSTRONG'S CLAIM, beneath a cover of about three feet of cement.

> "A bore was put down to a depth of 59 feet in the alluvial flat, on the banks of Bunbury Gully, to the east of the Amanda. No record appears to have been kept of the strata pierced, except that a very hard rock was met with when operations ceased. From the general features of the district it is quite evident that the alluvium cannot be very thick, but that the greater portion of the material lying above the hard rock is merely the decomposition product of the rocks beneath. Some chains further down the gully another bore, known as 'Webb's,' was carried down to a depth of 39 feet below the surface. It is stated that alluvial deposits of 17 feet in thickness rested directly upon a bottom of decomposed country. No further particulars are available with reference to the bore."

ENTERPRISE M.L. 369 (14¼ acres approx.) lies on the main road near the head of the gully. It includes a small portion of old M.L. 140, Acme. In December, 1905, Mr. W. D. Campbell reported on this lease, which is chiefly interesting as being a producer of tantalite as well as tin ore, as follows :—

> [*] "The principal one is M.L. 369, the Enterprise held by Messrs. Jones, Grey, and Marsh, and is on the main road about three-quarters of a mile south of the post office. An open-cut about 12 feet deep has been made on the west side of the road ; the upper seven feet shows a wash of tin and tantalite (6507, 6508, 6509) ; below this is kaolinised gneiss containing a micaceous lode formation, 18 inches wide (6506), slightly greenish in tint, but in places slightly ferruginous, carrying particles of tantalite and tourmaline from coarse dust to chunks, one inch in diameter. A drive has been put on the lode 30 feet. The lode is seen for 18 feet when it tapers out, but the micaceous formation continues and appears to be making again at the end of the drive. The strike of the lode is 323 degrees and the underlay 22 degrees to the south-west. A shaft, about seven feet deep, has been commenced a few yards further south to reach this lode further on the underlay. A pothole one and a half chains north-west of the last spot shows a somewhat similar wash (6508). Sample (6509) is the washed ore, ready for the market. This lease yielded 3.67 tons, worth £284."
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> [**] "On what is known as McNESS'S CLAIM, near the head of Bunbury Gully, a shaft has been put down to a depth of 28 feet, and work has been carried out upon the residuary gravels, of apparently somewhat low grade. A sample of the dressed ore (2508) presented to me by the owners, assayed 53.6 per cent. of metallic tin. A sample of the dressed ore from the adjoining claim, held by Messrs. Smith and Jones, yielded a very low return of metallic tin, viz., 41.7 per cent. (2513). No observations

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[*] W. D. Campbell, Assistant Geologist, Annual Report, Geol. Surv. Dept. 1906.

[**] A. Gibb Maitland, Govt. Geologist, Annual Report, Geol. Surv. Dept. 1900

have yet been made as to the cause of this low assay value. It is, however, worthy of note that the ground in the immediate vicinity of the above mentioned properties has yielded relatively large quantities of the mineral tantalite, a niobate and tantalate of iron and manganese. It may therefore be to the presence of this mineral that the low assay value of the ore on the claims above mentioned is due. Lower down in Elliot's Gully, on the ground held by Messrs. Brayney and Brennan, the tin ore was found to be associated with tantalite, stibiotantalite, ilmenite, garnets, and zircons."

From this gully has been won a very considerable proportion of the tin production of the field, but since it has been almost entirely held as claims it is almost impossible to arrive at even an approximate estimate of the quantity.

Four classes of deposits have been worked, first the alluvium of the existing creeks, secondly that of the older stream bed which occurs as a defined gutter upon the western bank, running practically parallel to the present gully, thirdly, lode shedding upon the bank between these two, and also a patch of gravel upon the eastern bank near the junction of the Bunbury with Elliott's Gully, and fourthly the tin-bearing pegmatite dykes.

Of the yield from the first class, as stated above, there is practically no record, and from the second only in the case of Nelson's old lease, which were held later on by Dilworth and Kramer, and now as the King Tin Leases are any returns available.

Since the year 1899, when first records were kept, these leases have yielded 97.56 tons of black tin worth £7,462.

So far no payable lodes have been discovered upon the western side of this gully, although small granite veins rich in tin have been encountered beneath the alluvium, upon the eastern side, however, there are numerous veins, but since these are as a rule very erratic and of small size, little work has been done upon them below the water level, whilst the portion of the weathered rock raised has been treated as alluvium.

Photo 2.

Photo by H. P. Woodward.

GENERAL VIEW OF SLUICING OPERATIONS.

* "HAPHAZARD M.L. 147.—Two shafts connected by a crosscut at 50 feet from the surface have been put down upon what has been regarded as 'lode matter.' Shaft No. 2, having been timbered to within a short distance of the bottom, prevents the sertion of rock pierced being examined. The foot of the shafts shows a decomposing tourmaline bearing gneiss, dipping west, and trending north 30 degrees east. The tourmaline is often of large size, and some very highly ferruginous ore is associated with it. From the foot of No. 2 shaft a crosscut 50 feet in length connects with No. 1 shaft. The first 30 feet of the crosscut from No. 2 shaft has been carried through a decomposing granite rock, succeeded by about 20 feet of tourmaline gneiss dipping to the west. No 'lode' has yet been discovered in the workings. In other portions of the property the residuary sands and gravels have been worked with fair results. Some of the material assaying (in the official laboratory) low in tin, viz., 11 per cent., was found to be associated with quartz, garnets, limonite, magnetite, tantalite, zircon, and ilmenite. This lease has yielded 8.72 tons of ore, valued at £550."

* "SALMON'S CLAIM 617.—This claim is situated on Bunbury Gully, to the eastward of the Yarana Lease. Two shafts have been put down to reputed depths of 15 and 27 feet respectively. Being full of water both were inaccessible to me. The owner, Mr. Salmon, informed me —and I have no reasan for doubting the authenticity of his information—that in the deeper shaft the 'wash' (residuary gravels, etc.) extends to about 16 feet from the surface, and that the rest of the sinking had been through a decomposing granite. I satisfied myself from sampling the dump that the material was stanniferous, and that the tinstone was coarse and angular, and could not have travelled very far from its parent source."

TAIRUA M.L. 410 includes part of old M.L. 124, Killarney, and is situated on the laterite ridge east of the Greenbushes Well. A lode has been worked in this property yielding 3.88 tons of black tin, valued at £390.

ESPERANCE HILL M.L. 389 (10 acres) includes part of old M.L.'s 124, Killarney, and 61, Yarana, and joins M.L. 410 on the south-west. During 1906 this lease produced a little lode tin, viz., 0.15 tons, of the value of £15.

NIL DESPERANDUM M.L. 401.—From this lease 0.55 tons of tinstone, valued at £104, have been obtained.

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* A. Gibb Maitland, Govt. Geologist, Annual Report, Geol. Surv. Dept. 1900.

DREAMLAND M.L. 382 (10 acres), includes part of old M.L. 61, Yarana. A tin lode running in a north-west direction has been described as occurring under a cover of 3ft. of cement. This lease has yielded 3.18 tons of ore, worth £340.

LOST AND FOUND NORTH M.L. 393 (includes part of old M.L. 146, Glencoe).—The Government Geologist's map of Greenbushes, issued in 1900, shows a lode in this lease parallel to that in M.L. 147. Reported output to end of 1907 was 3.23 tons, value £362.

LOST AND FOUND M.L. 374 (includes part of old M.L. 56, Amanda). Mr. W. D. Campbell visited this lease in December, 1906, and reported :—

> "Here a shaft 54ft. deep in kaolinised granite has been sunk on a lode composed of four veins or bands of about five inches each, in a total width of four feet, having an underlay of about 25 degrees to the east, and a strike of 40 degrees. The formation is gneissic, and slightly ferruginous in places ; no lode mining has previously been done here. The formation carries crystals of tin (6516) and tourmaline, and resembles the lode in the Cornwall lease. I was informed by Mr. Andrew that in the lead of tin-wash near here a solitary specimen of gold was found, weighing 1¼ grs., at 24 ft. depth."

Output :—

To end of 1905	0.75 tons	£70
1906	5.65 ,,	632
1907	1.30 ,,	110
Total	7.70 tons	£812

[*] "In the lower part of 'Bunbury Gully,' in the Amanda workings, there are veins carrying crystalline tin ore traversing the soft weathered granitic bed rock. These do not appear to me to be large enough to be called lodes, but are apparently fissure deposits rather than impregnations of a mass of country, and come therefore nearer to the lode type than to that of stockworks. Some of these veins contain nice bunches of tin ore, but none have been large enough for systematic work, and they have only been followed downwards a few feet into the weathered bed rock."

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[*] A. Montgomery, State Mining Engineer, Annual Report Mines Dept. 1903.

From this point downwards a deep lead has been recently discovered, which follows practically the same course as the existing gully. It has been worked as a series of claims, some of which at the junction of Westralia Gully have recently been acquired by a company, who have obtained 10.60 tons of tin oxide, valued at £846, from a run of wash 40ft. below the existing surface.

[*] "An important tributary, Elliott's Gully, enters the main channel of the Bunbury to the south of the bore hole just alluded to. A good deal of prospecting has been carried out along the course of the gully.

"The walls of the watercourse are hemmed in by the ferruginous conglomerate which forms the bulk of the watershed.

"The ground held by Messrs. Portwood and Burnet near the mouth of the valley, has been exploited by two shafts about 40 feet in vertical depth. The northernmost shaft exposed a series of cemented gravels, forming a true conglomerate in places, resting upon an uneven floor, which dips at an angle of about five degrees to the south-east. The bottom upon which the deposit rests is very clayey, and is derived from the disintegration of a very argillaceous rock. A very ferruginous sandstone or conglomerate rests directly upon the clay, and is covered with a whitish tourmaline bearing wash, which at the bottom is about six inches in thickness. The most southerly shaft, 40 feet in vertical depth, exposes a somewhat similar section. The floor upon which the deposit rests, dips at a low angle to the north-east, and evidently forms the southern bank of the watercourse. Above the conglomerate, at the bottom of the shaft, is a few feet of very white gritty sand, covered by about five or six feet of ironstone rubble, derived from the denudation and subsequent partial consolidation of the ironstone conglomerate which forms the bulk of the surface of the ground.

"The adjoining ground higher up the gully is held by Mr. Elliott. A great deal of work has apparently been carried out upon the property at different times. The main working shaft is situated near the northern bank of the gully, and has been carried down to a vertical depth of slightly over 50 feet. To the top of the 'wash' is 50 feet. The 'wash' is a very coarse conglomerate with a very large proportion of flat-sided boulders, cemented together in part with oxide of iron (1240). Tin shows freely in the different portions of the conglomerate. The average thickness of the deposit is about two feet. The conglomerate rests upon the upturned edges of a decomposed clay slate. which is vertical and which strikes south-east. Directly overlying the conglomerate, is, in places, a fairly extensive deposit of white gritty sand which contains detrital tourmaline. The main shaft is connected with a series of old workings, which expose a somewhat similar section.

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[*] A. Gibb Maitland, Govt. Geologist, Annual Report Geol. Surv. Dej 899.

"To the south of Elliott's an open cast, just on the edge of the flat, six feet in depth, discloses the following section :—

Yellow Surface Sand	2ft. 0in.
Ferruginous Cement	3ft. 0in.
Coarse "Wash"	1ft. 0in. to 1ft. 6in.

"Some little distance to the west of Elliott's a bore has been put down to a depth of 65 feet ; the bore was sunk with the object of prospecting for what may be called Elliott's Lead, but the location of the bore site proved to be too far to the north, and out of the track of the old watercourse. 'After passing through about six feet of ferruginous rubble, derived from the disintegration of the conglomerate which forms the northern edge of the gully, the boring tool entered a clay, almost identical in character with that underlying the wash in Elliott's main shaft. The bore was evidently carried through decomposing clay slate. The material at grass at a disused shaft to the west of Elliott's, and in the trend of the old watercourse, showed that the deposit was of a similar nature to that to the east.

"North-west of this, on Smith's Claim, two shafts have been sunk. The easternmost of the two had a vertical depth of 42 feet. The bottom of the shaft exposed a conglomerate wash, 18 inches in thickness, resting upon a floor of a decomposing clayey rock, which dips generally to the east at an angle of about 10 degrees. The clayey rock is traversed by a small quartz vein. The wash, which had been followed up on the rise for a distance of about 43 feet from the shaft, showed tin freely. The second shaft, some little distance to the west, had been carried down for a vertical distance of 33 feet with the apparent object of intersecting the wash in the adjacent working. The shaft passed through a very clayey deposit, in all probability resulting from the disintegration *in situ* of a very argillaceous rock. At a depth of about 23 feet, a tin floor made its appearance, but no steps had been taken at the date of my visit to exploit it.

"Upon the ground lying at the head of the gully, a good deal of desultory work has been carried out. Upon Nuttal's Claim the most northerly of the shafts disclosed a tin-bearing wash of 12 inches in thickness, covered by a gritty sand, carrying a fair proportion of tourmaline. This sandy bed occurred about 18 inches above the bottom wash, but only reached a thickness of six inches. From the mouth of the shaft the first eight or nine feet consisted of detrital ironstone conglomerate. The floor or bottom upon which these deposits rest is a decomposing clayey rock, probably a clay slate. The adjoining shaft to the south had been carried down to a vertical depth of 15 feet. The sinking showed detrital conglomerate, five feet; sharp gritty sand, nine feet; tin-bearing wash, one foot. The bottom has a slight underlay to the north-east. Five other shafts in close proximity shows a practically identical section."

This gully is historic owing to the fact that it was here that Mr. Stinton made his first discovery of tin, the area he secured covering the lower section of this creek at its junction with the Bunbury Gully.

Tin in small quantities was first discovered in the stream bed at the point of its intersection with the Greenbushes lead, but below the underlying cement a large deposit of sandy wash of considerable richness was encountered. This was sunk upon for a depth of 15 feet to a clay bottom, the whole thickness carrying tin in payable quantities.

On account of the large volume of water encountered it was found impossible to work this deposit without machinery, therefore a company called the Bunbury Syndicate was formed. Unfortunately, the plant secured proved to be utterly inadequate to deal with the influx of water, and, in consequence, a system of drainage by adit was adopted, but, owing to the very slight fall of the surface, this had to be carried so far, and was so costly, that the company was not in a position subsequently to equip the lease with suitable tin dressing plant.

The deposit was worked as an opencut, the dirt being drawn to the surface up an inclined tramway when it was puddled and washed. Since the adit was driven down the course of the stream, but at a lesser grade than the gutter, only a limited portion of this was drained, therefore, as the market value of tin happened to fall at about the time this was worked out, money was not forthcoming to exploit this lead further, and the lease was therefore abandoned.

Subsequently a large prospecting area was granted to a Victorian Syndicate, which covered most of the Bunbury end of the field, but, although a considerable amount of boring was done, this work was so lacking in system that the results were not sufficiently encouraging to warrant further work.

It may be mentioned that over £100,000 worth of tin ore has since been raised from the area covered by this concession, which is by no means worked out.

Returning again to the locality at which the original discovery was made, known as the Bunbury Hole, it may seem strange, considering that this area has been continually held for many years, that it is practically in as unprospected a state as it was at the time of its abandonment by the original company, this is due principally to the volume of water encountered in sinking, and the want of capital to cope with the same. This fine water supply has been utilised for tin dressing purposes, the wash dirt being carted from adjoining claims on to this area, large stacks of tailings from which now cover the surface.

The Greenbushes lead has now been traced down to it from the north and another lead worked by Elliott, Keyser and others from it in a westerly direction towards the Three C.'s, whilst yet another lead has recently been traced up the Bunbury Gully from the south to the boundary of this claim, as now held. As all these three radiate from this little block the indications point to the conclusion that a main deep lead crosses it, a junction occurring somewhere in the vicinity of the opencut, and this is further supported by the levels, since the bottoms of all these radiating gutters are deeper than the deepest large quantities, contained in a kaolin clay, whilst in this hole only a sandy wash, resting upon a clay bottom,'has point reached in the Bunbury Hole. In the wash met with in each of these leads boulders and pebbles occur in been encountered.

A careful examination of this clay discloses thin pipes or seams of fine tin grains, the particles when examined under a powerful lens are observed to be distinctly waterworn, therefore this is apparently not a true bottom, and this conclusion is supported by the fact that a shaft sunk some 8 or 10 feet from the bottom of which an auger hole was put down to a further depth of 6 feet, tapped so large a flow of water that work had to be abandoned.

This deep lead system of the Bunbury end has always been a knotted point, primarily owing to the fact that this central area has not been prospected, but since the three leads previously mentioned have now been traced towards it, it may be plainly assumed that it passes through it, and, since this is situated in the very heart of the richest tin-bearing portion of this end of the field, it is decidedly worth further prospecting.

WESTRALIA GULLY AND ITS TRIBUTARIES.

Westralia Gully, a second tributary of Bunbury Gully, enters from the west a little further south than Elliott's Gully.

> * "On the conglomerate tableland in the angle formed by the gully taking its rise near Hester's Troughs, and joining the main watercourse to the south of the 34ft. borehole, are several excavations which disclose the nature of the strata beneath the conglomerate. These show that the cover of conglomerate and residuary gravels is not very great, attaining as much as three feet in places. The conglomerate passes gradually into a tourmaline-bearing granite or gneiss, very rich in mica in places. Not far from the south-west corner of what was originally M.L. 82/43, there is 16 feet of wash reposing directly upon a decomposing clayey rock. At the bottom the wash contained, in addition to the tin, a large proportion of deleterious constituents, titanium, etc.
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> "The vicinity of Hester's Troughs has been the scene of vigorous prospecting. The higher ground to the south of the Troughs is covered with the ferruginous conglomerate, which forms a fairly well marked outcrop to the east and west. This deposit prevents an examination being made of the underlying rocks, a difficulty which, however, has been partially overcome by the prosperting operations. What is known as Wright's Shaft, on the northern slopes of the rising ground to the south of the Troughs, had been carried down to a depth of 28 feet vertically below the surface. The sinking showed detrital conglomerate, five feet; sharp gritty sand, nine feet; tin-bearing wash, one foot. The bottom has a slight underlie to the north-east. Five other shafts in close proximity show a practically identical section. The sinking showed nothing but a clayey rock, which had a dip to the south-east at an angle of about 45 degrees. In the vicinity of the shaft several very large pieces of angular tin, one weighing about 3lbs., have been discovered. From their distinctive characters it is

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* A. Gibb Maitland, Govt. Geologist, Annual Report Geol. Surv. Dept., 1900.

quite evident that the tin cannot have travelled far from its parent source. On the flat ground to the north several excavations have been made, and they all unite in giving what is practically a uniform section, which consists of from two to three feet of peaty soil, succeeded by a variable thickness of white gritty sand, carrying varying proportions of mica and tourmaline. This deposit results from the residual composition of a granite rock, although operations have hardly been carried sufficiently far to reach the sound rock."

"LAST CHANCE M.L. 172 (149).—This property lies near the southern boundary of the field, some distance to the south of Hester's Troughs, and considerably beyond the limits of the country prospected at the date of my previous visit to the district. A vertical shaft had been put down to a depth of 38 feet. The sinking showed about eight feet of conglomerate succeeded by a tourmaline-bearing rock, trending north 20 degrees east, and dipping to the westward at a high angle. The width of the deposit was about two feet three inches, but at the foot of the shaft it reached as much as four feet six inches. An assay (2519) of what appeared to be a characteristic sample of the concentrates from this rock yielded 52.4 per cent. of metallic tin, whilst a sample (2520) from the dump yielded 43.8 per cent. of tin. The relatively low percentage of the tin in these two samples is chiefly due to the somewhat crude method of washing in the dish. The tin ore seems concentrated round a joint plane, by which the country rock is traversed. In the material in the dump tin ore could be seen embedded in a friable quartzose matrix, which does not, however, seem to be derived from a quartz reef, but is rather a portion of the country rock in the vicinity of a joint plane from which, by the solution of felspar, silica has been set free to produce quartz."

"OFFER and GILBERT'S CLAIM.—This property lies a little distance north of the 'Last Chance.' A shaft has been sunk to a depth of about 40 feet vertically below the surface. The shaft itself is not straight, but has been sunk partly vertically and partly inclined, its course having been determined by that of the ore body. The shaft, which has not yet been sunk far enough to reach sound rock, follows down a rock decomposing in the direction of kaolin and carrying very coarse tin and tourmaline. The ore deposit is merely an impregnation along a line of weakness, either a joint plane or a fracture. So far as work has at present been carried, it seems that this impregnation has extended across a width of about two feet six inches to three feet. A characteristic sample of my own selection from the foot of the workings was carefully washed for the purpose of concentrating the tinstone, which was found

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* A. Gibb Maitland, Govt. Geologist, Annual Report Geol. Surv. Dept. 1900.

to assay (2514) 63.4 per cent. of metallic tin. This percentage, of course, gives no indication of the quantity of tinstone in the matrix. The cassiterite itself was very brittle, owing to its being traversed by strings of decomposing country rock."

Between the Westralia Gully and the Three C.'s are some extensive shallow workings where sluicing is being carried on upon a small scale. This patch of ground, which is called Poverty Flat, will in all probability prove to be a false bottom above a deep lead.

Cowan's Brook proper takes its rise near the head of Elliott's Gully, at an elevation of 850 feet above the sea level, but its two main branches, which are in reality sandy flats, drain the country to the northward for a considerable distance, their heads being 900 feet above sea level.

The head of this gully consists of a large water-logged sandy flat, called the Three C.'s, after the original holders of the lease, Messrs. Cowan, Castella, and Clark. In this flat tin in small quantities occurs in the sand from the surface downwards, it appears of a lacustine origin, having been deposited at a subsequent period to that at which the deep lead crossed this area as an open valley, and prior to the cutting out of the present deep channel of Cowan's Brook.

In the bed of this gully at the foot of the flats a considerable amount of sluicing and dredging work has been carried on, the wash being of a heavy nature, consisting mostly of large white quartz pebbles and boulders.

During the last few years this has been worked by a company, who have washed 64.18 tons of tin, worth £5,891.

No attempt so far has been made to trace the deep lead which crosses the gully at this point into either bank, all prospecting having been confined to following the secondary tin derived from it in the stream's course below.

After leaving the sandy flat the gully closes in, with crystalline rocks outcropping upon the northern bank, capped by laterite.

Below its junction with the Moulton Brook the boulder wash is again met with carrying tin beneath the bed of the gully, but a short distance lower down even this has been entirely swept away by the stream down to the granitic bedrock.

Moulton's Brook, which is more commonly known as Battler's Gully, takes its rise upon a low saddle about 830 feet above the sea level. This low ridge is capped with laterite, and forms the water parting between this gully, the Three C.'s, and Paper Bark flats.

In the upper portion of its course there is no defined water course, the whole valley between the laterite hills being one sandy flat, lower down, however, where some shallow workings are situated, a heavy boulder wash is met with beneath the surface covering of sand, which wash is also exposed upon its northern bank, near its junction with Cowan's Brook.

The quantity of tin obtained from this gully was inconsiderable and of a low grade, owing to the presence of heavy base metals, which rendered dressing to a high standard next to impossible.

BATTLER'S HOPE M.L. 313-314.—These old leases are situated at the head of Moulton's Brook, more generally known as Battler's Gully, and upon these, close to their dividing boundary, two deep shafts have been sunk, with the object of prospecting for a deep lead.

The southern of these two was sunk to a depth of 126 feet, cutting the wash at 96 feet 3 inches, where it was about 15 inches in thickness and composed of numerous large well waterworn boulders of quartz, quartzite, greisen and mica schist, with softer much decomposed rounded boulders of clayey ironstained rock, the whole being intermixed with ferruginous earth and sand.

At a depth of 106 feet below the wash a level was driven south-west in decomposed mica schist for a distance of 120 feet, which rose into it at a distance of 50 feet from the shaft. Another drive was also carried 40 feet north, when work had to be abandoned owing to the collapse of the shaft bottom.

Another shaft was sunk a little farther north to a depth of 103 feet, bottoming upon a hard diorite bar, which was driven in 6 feet. The wash in this shaft was cut at a depth of 93 feet, whilst a level drive 60 feet south from the shaft rose into it at a distance of 30 feet.

* "From the appearance of the larger boulders at surface it is evident that a true 'wash,' or river-worn bouldery gravel, was encountered, pointing to the existence in past times of running streams of considerable carrying power, and to different climatic conditions from those now prevailing.

"A little tin ore was obtained by Mr. Johnston while working the 'wash,' but it was altogether too poor to be payable. The presence of the ore, nevertheless, gives ground for thinking that the 'gutter' of the lead, when found, is likely to carry payable deposits. Above the 'wash' there was in the shaft about four feet of dark clayey matter, covered by two feet six inches of fine drift, from which a good deal of water made into the shaft. On top of this drift there was a thin hard band or layer of oxide of iron cement, then 50 to 60 feet of brown mullocky material, with iron oxide concentrations and angular pieces of quartz. Mr. Johnston tells me that this has been repeatedly mistaken in the district for the true bedrock. Near surface the ground is hard white and brown cemented grit and sand. The succession of strata is as described by Mr. Johnston ; the shaft being full of water I could not further verify them.

"The 'wash' and boulders at this shaft were very similar to those at the 'Hard Graft' and adjacent shafts above mentioned, and I think there is much likelihood of their being all on the same deep lead.

"This deep lead has evidently nothing to do with the present shape of the surface, its course being quite independent of the modern watercourses, and the latter are no guide as to where it might be expected to be met with. To the westward of the 'Battlers' Hope' it may be entirely removed by the modern erosion of the country, in which case some trace of it should be found where the old channel emerges on the more recent surface, or it may possibly continue as a buried lead, in that case probably going out somewhere towards the junction of Cowan's and Norilup Brooks. At Johnston's shaft the belt of deep ground is some 15 chains in width with shallow ground to north and south, and as the bedrock in the levels was dipping to the north-west it is evident that the shaft must be on the south side of the 'gutter,' though fairly well in the centre of the belt of deep ground. The next shaft should therefore be sunk farther to the north."

SALT WATER GULLY AND ITS TRIBUTARIES.

Salt Water Gully, which flows into Hester's Brook, rises to the south-east of the railway station at an elevation of 890 feet above the sea level and falls to the south south-east. It receives three tributaries from the west ; the first (Scandinavian Gully) begins a little north

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* A. Montgomery, M.A., F.G.S., State Mining Engineer, Annual Report Mines Department, 1903.

of M.L. 116; the second (Floyd's Gully) rises in M.L. 383 near the main road; and the third (Kelly's Gully) in M.L. 182. Tin ore has been obtained from the main gully and all three branches, but records are wanting, as they have for the most part been worked as claims. Laterite covers the higher ground in this watershed, but granite and gneiss appear at the surface in the lower part of the valleys.

CENTRAL GROUP OF LODES.

* "CORNWALL M.L. 40.—This property, which is the oldest lease upon the field, lies near the centre of the tin-field, and not far from its highest point. A three-chambered shaft has been sunk to a depth of about 120 feet, and is closely timbered throughout, thus preventing a section of the rock passed through being examined. The present holders of the property did not sink the shaft to 100 feet, this depth having been attained by previous owners. The last 20 feet of the shaft put down by the present holders being full of water was not open to inspection. At 100 feet a crosscut has been put in due east about 49 feet, connecting with the workings in an old shaft adjoining. The rock exposed in the crosscut is a dark highly micaceous schist, dipping at a high angle to the west. The workings in the old shaft show that the place of the mica schist has been taken by a granitic rock, the 'lode' (greisen) consisting essentially of quartz, a greenish mica, and a little felspar. The rock itself is tin-bearing. In 1899, on visiting this mine which had been abandoned, and was consequently inaccessible, I carefully sampled the material lying on the dump, which, on assay in the official laboratory, yielded tin to the extent of 1.79 per cent. About 2¼cwt. of the greisen from the property was recently bagged and forwarded to the Mines Department, and subsequently carefully assayed. The ore was contained in three bags, the first sample (2493) weighing about 1cwt., yielded 0.55 per cent. of tin; the second (2494) weighing about 1cwt., yielded 3.46 per cent. of tin; whilst the third (2495) which weighed about 0¼cwt., yielded tin to the extent of 1.09 per cent. The old workings in the crosscut show that the tin-bearing greisen, which is not of any great width, has been subjected to dislocation, as shown by the slickensided faces. This faulting introduces certain elements of uncertainty as to the unbroken continuity of the ore body in the mine in depth, though not as to the permanency of the tin ore, which, finding its origin below the limits of practical mining, is likely to persist to great depths. Whether the ore will prove sufficiently concentrated to be payable can be best determined practically."

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* A. Gibb Maitland, Government Geologist. Annual Report, Geological Survey Department, 1900.

Mr. W. D. Campbell writes of this property in December, 1905 :—

> † "The old workings comprised several shafts from 60ft. to 120ft. deep on the various lines of lode, of which there appear to be four in number, striking about 161 degrees, with a westerly underlay of 84 degrees. The two western lodes at least are in decomposed granite, and either one or two of the eastern lodes are probably in the dark mica schist (6514) showing in the dump of the 120ft. shaft. Very little stoping appears to have been done by the past owners. . . . The present owners have been stoping and driving from the old workings at 60ft. to the surface of the decomposed rock, which is overlaid by about 7ft. of tin wash and gravel. They state that they found rich patches of ore. They have also sunk several minor shafts with drives and stopings, and have been well satisfied with the mine. . . . I inspected part of the workings down to 50ft. depth . . . the lodes are somewhat sinuous, and vary from 18in. to 3ft. in width, and are approximately parallel, though probably not all continuous through the lease."

This was the first lode worked in this locality, the shaft being sunk by a company in the early days of the field, owing, however, to the low price of tin at the time, the necessary capital could not be obtained, and since there were no crushing plants in the district the ore could not be treated, therefore it was abandoned.

Later on this lease was again taken up by a Kalgoorlie Syndicate, who held it for a number of years, but did little work upon it. In 1904 it passed into the hands of the present owners, who have taken out a considerable quantity of tin.

The surface of this lease is covered with laterite, but the lode- lines are indicated by the presence of tourmaline at the surface. The lodes themselves consist of pegmatite and greisen, dykes containing quartz, albite, muscovite and tourmaline. The country is usually highly weathered to a depth of 50 feet, but below this a hornblende biotite schist is met with, which is, in all probability, the result of altered bronzite diabase rock.

The lodes have been worked from the surface down to a depth of 40 or 50 feet, or the zone of much weathering in which the felspars have been converted into kaolin and in consequence little crushing is required.

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† Annual Report Geological Survey Department, 1905.

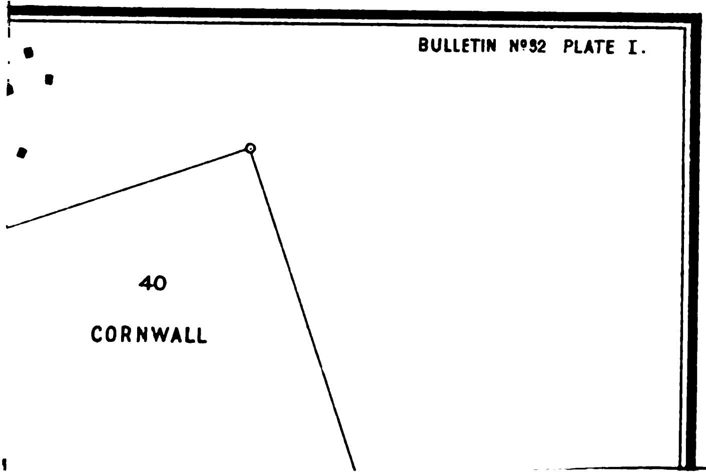
There are three distinct lodes upon this lease, the first one worked being situated at about its centre. This lode has a course a little east of north with a dip to the north-west, it was first opened at its cap by two underlay shafts, which followed down a fairly rich pipe of ore. Later on a small vertical shaft was sunk to a depth of 100 feet, and later still a three compartment main shaft with a cross cut to the other workings. This lode is a good deal broken and cannot be traced for more than 50 feet at the surface. The next lode lies about two chains north-west of the main shaft, and has been traced for a distance of three chains, following the normal course of a little west of north with a dip to the south-west. It is of good size, attaining as much as 14 feet in width in places, and has been worked to a depth of 30 feet for a length of about 120 feet, yielding very good returns; whilst the lodestuff like that from the upper workings in the first mentioned is very highly micaceous.

The next lode lies about two chains to the westward, and follows a parallel course to the last mentioned, it has been worked for a length of 7½ chains to depths varying from 30 to 50 feet. The size was apparently very variable, being as much as 10 feet in places, whilst at others it was small. The official records show that this mine has produced up to the end of 1907, 37.78 tons of black tin, which realised £3,236.

So far only the weathered rich portions of the lodes have been worked, on account of the cost of treatment, since all the stone has to be carted for a distance of from one to two miles and treatment paid for. As there is every indication that an ample supply of water will be obtained by sinking upon the lodes, if a plant were erected upon the lease, the cost could be so greatly reduced as to render the treatment of the harder and lower grade stone possible.

SOUTH CORNWALL M.L. 300 (20 acres).—Lies to the west of M.L. 356, and includes old M.L.'s 101, 89, and part of 54. In this lease a lode parallel to those in the Cornwall has been worked, and near the surface yielded some of the richest lode stuff yet raised on the field (4660). Mr. W. D. Campbell writes in December, 1905 :—

BULLETIN Nº 32 PLATE I.



> "The main shaft is 80ft. deep, and the lode adjacent is stoped from 63ft. to the surface for a width of 8ft. from the western side, where the schist is more decomposed. There is a crosscut east for 78ft., which the owners state is tin-bearing all the way. . . . the country rock is mica schist. About 100ft. farther north the lode has been opened up by a 50ft. shaft, and is stoped from 50ft. to surface for about 250ft. in length."

Some of the richest ore from this mine (4660) was very micaceous, being composed of pale-green muscovite, quartz, topaz, and very coarse tinstone. A large specimen (7198) from a depth of 130ft., recently received from this mine, shows a compact somewhat banded lode composed mainly of albite, with quartz, tourmaline, topaz, and cassiterite ; 19.64 tons of tin ore have been won from this mine, which realised £1,564.

> "At the time of my visit to the South Cornwall the shafts on the property were full of water, and only the dumps could be examined. Portions of these gave good prospects of tin ore on washing. The tin-bearing formation, or stockwork, is said by Mr. Johnston to be some 100ft. in width, but not yet to have been properly cut through. The east wall is dark micaceous schist. The tin-bearing rock has quite the stockwork characteristics above described, and I have little hesitation in grouping it in this class of ore deposits. The deepest shaft is stated to be 65 feet in depth, and some excellent ore was obtained from it. Mr. Johnston informs me that altogether about 600 cubic yards of material have been washed, for a return of 10 tons of black tin, or dressed tin oxide. This is, approximately, 1 per cent. tin ore per ton of rock, which might be payable under favourable conditions of mining and dressing. Less than one half per cent. of tin ore has been made to return a profit, under favorable conditions, at the Anchor mine in Tasmania. [*]
>
> "Mr. Johnston tells me that the water level in summer in his shafts is at about 65 feet, and that down to that depth the rock is soft and easily sunk through. In winter the shafts become filled to the surface, but the influx of water is not so great as to present much difficulty in working. The idea in the district heretofore appears to have always been to sink deeper, in the hope of defined lodes being met with, but the behaviour of stockworks hardly warrants this course. The probabilities are in favour of there being little change in the character of the rock, except that it will naturally get harder below the surface zone of weathering. It does not seem to me that there is any better chance of getting good ore in depth than near the surface, and the shallow ground is much less costly to work."

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[*] A. Montgomery, M.A., F.G.S., State Mining Engineer, Annual Report Mines Department, 1903.

Upon this lease a considerable amount of work has been done, and the greatest depth as yet attained upon the field reached, whilst a three compartment 200 feet vertical shaft is being sunk with the assistance of the Government.

The lode has been traced at the surface for a distance of 7 chains and been worked to depths of from 40 to 130 feet, the lode matter between the walls attaining a width of 20 feet 6 inches at one point. The lodestuff is not so micaceous as that met with in the Cornwall mine, but that worked is on the whole richer, whilst some was of high grade. The average higher value of the material treated cannot be taken, however, as a criterion of the whole lode mass, since it has not been removed in such a systematic manner as in the Cornwall.

The rock passed through in sinking the main shaft is a biotite hornblende schist with veins of quartz and granite, the latter being sometimes heavily charged with arsenical pyrites and carrying a small quantity of cassiterite.

DIXIE M.L. 388 (24 acres).—On the laterite ridge immediately east of the town is situated this lease, which includes part of old M.L.'s 71, Jeffery, 156, New Zealand Syndicate, and 104, New Guinea. A lode is being worked in this property, of which specimens from a depth of 120 feet are in the Departmental Museum (6998). These show that the lode is a pegmatite vein, composed largely of albite, with lesser quantities of quartz, tourmaline, muscovite, garnet, and cassiterite.

The lode in this property has a north-westerly course, dipping to the south-east, and can be traced for a distance of 14 chains. It has been prospected by a number of shafts, sunk to depths varying from 50 to 120 feet, in which it has varied considerably in size, but reaching as much as 12 feet in places, some of the stone being of exceptionally high quality.

There are also a series of north and south veins which strike off from the main lode in a southerly direction, these are five in number and average about 3 chains in length, and have been prospected by a number of shafts sunk to depths which vary from 30 to 70 feet.

This property has so far yielded 22.16 tons of tin oxide worth £1,763.

BULLETIN N° 32 PLATE II.

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HYDRAULIC SLUICING.

Photo by H. P. Woodward.

ty has so far yielded 22.10 tons of [illegible]

PHOTO 3.

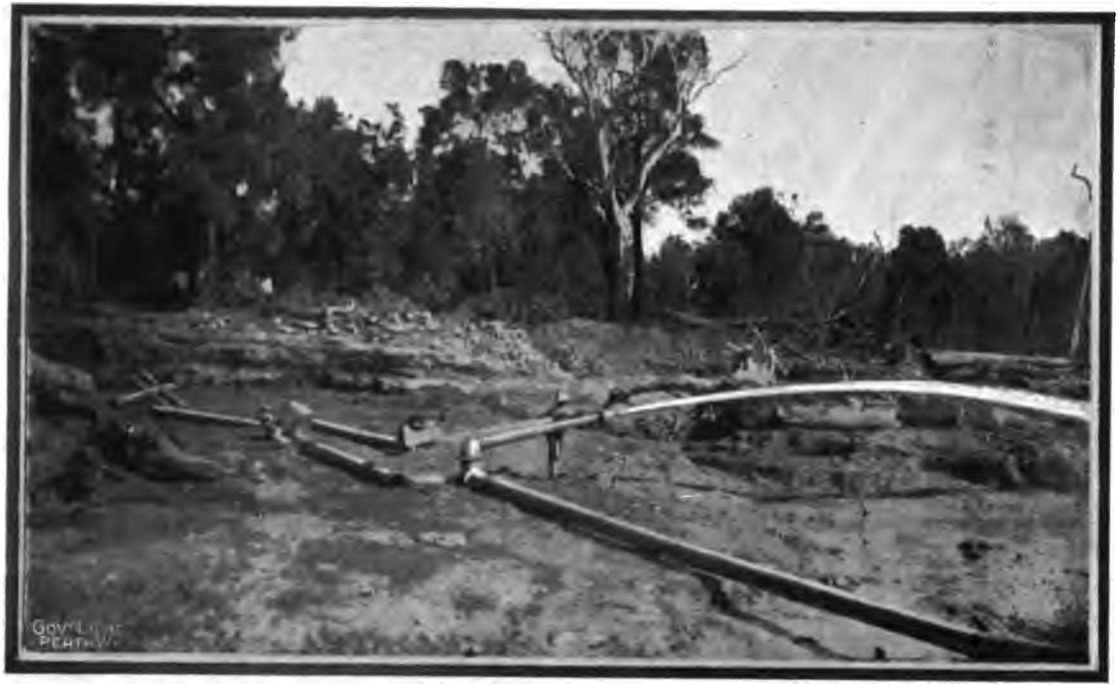

Photo by H. P. Woodward.

HYDRAULIC SLUICING.

* "RUBY TIN MINING CO., M.L. 158.—Two shafts have been sunk upon the lease to a vertical depth of 80 feet each. The main shaft was inaccessible to me, but the material at grass showed the sinking to have been through ferruginous mica schist. The present working shaft has been carried down through decomposed micaceous schist, traversed by a few quartz leaders, the whole formation underlying to the west. From the foot of the shaft a crosscut 37 feet in length has been put in to the westward with the object of connecting with the main shaft. The crosscut exposes nothing but fine grained micaceous schist, traversed by quartz veins. Near the face of the drive two barren-looking quartz reefs of about 12 inches in thickness dip at a fairly high angle to the west. A crosscut, 20 feet in length, has been put in to the westward from the 50 feet level. It exposes nothing but ferruginous mica schist, with gneissic bands. Twenty feet higher up the shaft, a drive has been put in to the south-west, for a distance of 14 feet, but it laid bare nothing but schist with tourmaline. No semblance of a lode has been opened up anywhere in that portion of the workings accessible to me."

"QUEEN OF GREENBUSHES, M.L. 80.—Three vertical thafts have been put down in close proximity to each other upon the property. The most northerly, No. 2 shaft, had been carried down to a vertical depth of 60 feet, through a white granitic rock, carrying small quantities of tourmaline. From the foot of the shaft a drive had been put in to the north for a distance of 15 feet through a whitish granitic rock identical in character with that passed through in the shaft. At nine feet from the face the granite gives place to a clay, which may represent the decomposition product of a porphyry. The junction between the two deposits dips to the south at an angle of from 40 to 50 degrees. The drive has been continued southwards from the shaft, through a similar granitic rock, for some distance until it intersects another drive trending east and west, connecting with No. 1 shaft. Where the two drives intersect, a winze has been sunk for a vertical distance of 18 feet to what is known as the 80 feet level. A few feet below the floor of the level in the winze a fairly large quartzose portion of the granite which carries tourmaline is said to have yielded fair prospects of tin. None, however, was visible to me. No. 1 shaft, 60 feet in depth, has been sunk through a rock carrying a little mica and decomposing in the direction of kaolin, in all probability a granite of the type prevailing on the field. A drive has been put in a few feet south from the shaft through clayey country, intersected by a quartz leader. No. 3, or the Main Shaft (five feet by three feet) has been carried down to a depth of 100 feet, through a decomposing granitic rock. From the bottom of the shaft a drive has been put in to the westward for a distance of 20 feet. The face of the drive exposes a hard foliated quartzose granitic rock with tourmaline, inrlined at a steep angle to the westward, and trending approximately north and south. What may be called the hanging wall of the foliated granite is a highly micaceous schist which has been penetrated a few inches. The thickness of the foliated granite—the so called lode—is about 10 feet. A carefully selected sample of the 'lode' yielded, on assay in the official laboratory, an appreciable quantity of tin, viz., .09 per cent. On the arrival of my specimens in Perth, it was found that certain fragments of metallic tin —not obtained from the "lode'—were included in the sample. These were, of course, extracted before assaying. A small sample of the dressed ore from the property yielded on assay 47.6 per cent. of metallic tin. A great deal of genuine labour has been done upon the property, which the owners inform me represents about £600 in cash. There is no true fissure lode opened up anywhere in the mine, the appearance of a hanging and foot wall being due to the jointing of the country rock, and a deceptive indication from a miner's point of view."

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* A. Gibb Maitland, Govt. Geologist. Annual Report, Geol. Surv. Dept., 1900.

List of Rocks in the Geological Survey Museum from the Greenbushes District.

Reg. No.	Description.	Locality.
687	Stanniferous Gneiss ..	½ m. S.E. of Post Office ? (M.L. 356, Cornwall
703	Cassiterite in Albite Pegmatite ...	Greenbushes Well, Greenbushes.
1242	Granite	Spring Gully
1243	Coarse Graphic Granite	Junction of Gibney's and Dumpling Gullies
1244	Decomposed Granite ...	Sugar's Claim, Head of Spring Gully
1245	Crushed Foliated Pegmatite ...	M.L. 40, Cornwall
1246	Quartz Tourmaline Rock (Schorl Rock) ...	Greenbushes
1247	do. do. ...	do.
1277	Weathered Gneiss ...	Larkin's New Find, Greenbushes
1288	Weathered Quartz Tourmaline Lode...	Webb's Mine, M.L. 146(?) Bunbury Gully
1645	Tourmaline Granite ...	Greenbushes
1927	Crushed Foliated Pegmatite ...	Cornwall Mine (?)
1990	Foliated Albite Rock ...	Greenbushes
1999	Crushed Foliated Pegmatite ...	Cornwall Mine
2022	do. do.	M.L. 80, Queen of Greenbushes, Floyd's Gully
3004	Quartz Tourmaline Rock (Schorl Rock) ...	M.L. 233, Nelson Extended, Bunbury Gully
3005	Weathered do. ...	do. do.
4860	Pegmatite (?)	M L. 46, Greenbushes
5198	Bronzite Diabase ..	Bunbury Gully, Greenbushes
6254	Blue Tourmaline in Pegmatite ..	Greenbushes
6510	Cassiterite in Lode (Quartz-Mica) ...	M.L. 356, Cornwall

List of Rocks in the Geological Survey Museum from the Greenbushes District.

Reg. No.	Description.	Locality.
6511	Cassiterite in Quartz-Tourmaline Lode...	Depth 50 ft. Cornwall
6512	Cassiterite in Quartz-Mica Lode ...	Depth 30 ft. Cornwall
6514	Hornblende-Biotite Schist	129 ft. V.D. Eastern Shaft, Cornwall
6515	do. do.	92 ft. at Drive in 110 ft. shaft, M.L. 314, Battler's Hope
6517	Cassiterite in Lode, (Albite, Tourmaline, Quartz, Garnet, Muscovite)	M.L. 375, Glasgow
6518	Cassiterite in lode (Quartz, Tourmaline)...	Lower Level, Glasgow
6998	Cassiterite in Lode, (Albite, etc.) ...	120ft. Main Shaft, M.L. 388, Dixie.
6999	Decomposed Hornblende Schist	About 100 ft. V.D. do. do.
7000	Bronzite Diabase (?) ...	South Side of Loc. 991, Greenbushes
7028	Cassiterite in Quartz-Mica Lode and in Albite, Quartz, Tourmaline Lode...	90ft. level M.L. 300, South Cornwall
7198	Cassiterite in Lode (Albert Quartz, Tourmaline, Topaz)	130 ft. M.L. 300, South Cornwall
7322	Bronzite Diabase ...	M.L. 374, South Greenbushes
7323	Weather Hornblende-Biotite Schist ...	do. do.
7324	Greisen	Portwood & Bonnor's Claim, South Greenbushes
7325	Quartz Tourmaline Rock (Schorl Rock) ...	Well, State Battery, Greenbushes
7665	Granite	The Mill Brook, Greenbushes.
7666	Gneiss	do. do.
7667	Granite	Dumpling Gully, Greenbushes
7668	Gneiss	do. do.
7842	Albite-Pegmatite ...	South Cornwall, Main Shaft
8282	do.	do. do.

PART II.

A Report upon the Mount Malcolm Copper Mine, Eulaminna, Mount Margaret Goldfield.

INTRODUCTION.

When the proofs of the matter for the Baser Metals Bulletin, No. 30, were being read, it was suddenly discovered that the greatest producing copper mine in the State had not been examined by an officer of this Department, the Hon. Minister for Mines therefore instructed the present writer to proceed there at once, in order that a short description might be included.

The following is the full report submitted, but this is not nearly so complete as could be desired, owing to the fact that the inspection had to be very hurriedly made in order to avoid delay in the publication of the Bulletin before referred to.

THE Mt. MALCOLM COPPER MINE.

This important property, which consists of M.L.'s 4F, 5F, 11F, and 12F, is owned by the West Australian Copper Company, Ltd., and is situated at Eulaminna (better known as Anaconda), four miles south-west of Murrin Murrin in the Mt. Margaret Goldfield. It is upon the Laverton branch of the Eastern Goldfields Railway line, 163 miles north of Kalgoorlie and 538 miles north-east of Perth.

It was worked from the year 1899 until 1903 as the Mt. Malcolm Copper Mine, but in the year 1904 it passed into the hands of the Murrin Murrin Copper Mines, Ltd., it was equipped with the necessary plant and a large water jacket furnace, but for some reason not apparent this company went into liquidation, and disposed of the entire plant and leases, the latter being purchased by Mr. Blakemore, managing director of the present company. At the time of purchase little ore of a payable grade is said to have been visible, but prospecting work was energetically pushed on with, and was rewarded by the discovery of two rich bonanzas. With this encouragement the mine was again equipped with up-to-date winding plants and pumps, and two reverberatory furnaces were erected, whilst a third is nearing completion ; it is also proposed to shortly construct a blast furnace with the object of treating a large quantity of low grade ore that is in sight in the mine.

The lode gives little indication of its presence at the surface, the only evidence being isolated jaspery quartz outcrops at the north end. Its general course is northeasterly, with a dip of about 65 degrees to the eastward, but, although the draining of the northern workings by the unwatering of the deeper southern evidently indicates that all the deposits so far opened are upon one main line of fissure, their individual appearance does not produce this impression, since they do not follow one common direction, therefore it will most probably be found upon further development that the individual areas of enrichment follow planes which cross the ore channel at variable angles.

The workings may be divided into three groups, of which the southern are the most extensive, consisting of a main vertical shaft 386 ft. 6 in. in depth, with levels at depths of 85 ft., 192 ft. 6 in., and 298 ft. The upper of these, which is called the No. 1 level, is connected with the main shaft by a crosscut 40 feet west, it has been driven north for a distance of 130 feet, and is connected with the surface by the No. 1 prospecting shaft at the end of the level, at which point the country has been crosscut for a distance of 40 feet east and 45 feet west. Southward from the main shaft the level has mostly been filled in, but it originally extended at least 200 feet, or as far as the windmill shaft.

The No. 2 level has been driven 100 feet north and 310 feet south from the main shaft, and above it the ore body has been stoped for a length of 295 feet.

The No. 3 level has been driven 60 feet north and 225 feet south, but little stoping has as yet been done between it and the No. 2 level, as the ore does not generally prove to be of a high enough grade to smelt in reverberatory furnaces without concentration.

The ore body in these workings has been stoped from the surface south of the main shaft down to a depth of 192 feet, and for a length varying from 210 feet to 300 feet, and width of from 5 to 18 feet. This ore body appears to consist of two lenses, the southern one being smaller and more siliceous, a break occurring between it and the northern lens, which varies from 5 to 12 feet at the surface, increasing up to 27 feet at the No. 1 level, and to 40 feet at the No. 2 level, in which latter a solid mass 18 feet in width is still visible near the shaft, the ore stoped ranged from 15 to 25 per cent.

From the surface down to the water level, which is at a depth of 90 feet, the ore consists of blue and green carbonates of copper with oxide of iron contained in a siliceous matrix, the whole carrying a small quantity of gold and silver.

Immediately below the water level the lode often consists of a ferruginous gossan with silicate of copper (chrysocolla) and secondary silica (chalcedony), followed by rich red oxide (cuprite) and native copper for a short distance only, when it is replaced by dense black sulphides consisting of copper glance (chalcocite) and iron pyrites, a small quantity of peacock ore (bornite) was also met with near the apex of the sulphides, whilst a little zinc blende was also found at a depth of about 200 feet.

In the No. 3 level a large body of low grade ore was encountered, which ranges from 1 to 10 per cent. of copper, it consists mostly of iron pyrites often in a semi-decomposed state, with a certain amount of powdery black sulphide of copper.

The water in this level is heavily charged with sulphate of copper, the drip from the roof often forming stalactites of blue stone, but when this water comes in contact with the iron it is rapidly replaced by metallic copper, whilst a drip upon either the tram lines or truck wheels rapidly cuts into them. A quantity of valueless powdery ore, consisting mostly of pyrites, stowed in this level, was becoming rapidly cemented by the copper salts, which are also doubtless replacing the iron sulphides. At the end of this level the ore body apparently bifurcates, but since both these veins are small and of low grade further driving in this direction was discontinued.

It may be mentioned here that this level has only recently been unwatered and sampled, owing to the fact that the shaft had to be secured, since the nails, bolts, etc., had been corroded and replaced by copper, as also had the pumps and pump column.

Information is not available as to whether the shaft has passed through the zone of saturation, but this will shortly be proved when the country is crosscut from the shaft bottom, which latter has just been cleaned out with that object.

The middle group of workings are situated 460 feet north of the main shaft, and have been opened by what is called the magazine shaft, which was sunk to a depth of 100 feet with a crosscut at 79 feet from the surface, This crosscut has been driven west for a distance of 30 feet and 120 feet east cutting the formation at a distance of 90 feet from the shaft, where a short level was driven 20 feet upon low grade ore, whilst a winze was sunk upon it, which cut a rich body at a depth of 31 feet. This was followed down for a further depth of 32 feet, in which distance the ore averaged from 30 to 35 per cent., its size is as yet unknown, but at the bottom of the winze it is over 7 feet in width.

This ore consists of a solid mass of copper glance (chalcocite) and iron pyrites, the bonanza being capped by a small quantity of cuprite and native copper above which was a layer of siliceous oxide of iron and gossan, then a crust of silicate of copper beneath secondary silica, above which was a cavity of a few inches between this rich body and the low grade ore above.

These workings are dry, although 40 feet below the ground level, this is probably due to the unwatering of the southern workings, which would suggest that they are upon the same line of fissure although not upon the same ore body.

The northern workings, which lie 330 feet north of the magazine shaft, consist of two independent series, the first or southernmost has been opened by the No. 3 prospecting shaft to a depth of 86 feet from the bottom of which a crosscut has been driven 30 feet east and west, and a level on the lode 40 feet in length, from which a winze was put down 14 feet.

These workings appear to have been opened with the object of testing the lode below a rich surface bunch of ore, worked from what is called the middle opencut, which was 120 feet in length, 20 feet deep, and varied in width from 15 feet at the surface to 2 feet at the bottom.

A little to the north of these workings is main shaft No. 3 north, which is 146 feet deep, whilst further north are the No. 2, 130 feet deep, and No. 1, 70 feet deep, from the bottom of the latter a level called the No. 1 has been driven south for a distance of 180 feet, which connects all these shafts. From this level the formation has been crosscut at three points, the first from the north end being driven 60 feet east, the second at the main shaft 40 feet east and west, and the third 20 feet east at the south end.

Although this level is directly below, a point at which a rich surface patch consisting of a body of carbonate ore 100 feet long, from 12 to 15 feet in width, and 30 feet in depth, was worked from an opencut, no downward extension of it appears to exist.

From the bottom of the main shaft a crosscut has been driven 70 feet east to the formation, which has been driven on north and south in low grade ore.

Between the Nos. 1 and 2 levels at a depth of about 90 feet below the surface a very rich pipe of sulphide ore, assaying 70 per cent., was cut, which has now been followed down by a winze for a distance of 80 feet, or to just above the No. 2 level.

The water level in these workings, owing to the greater elevation at the surface, was 120 feet, but since the lower workings at the south end have been unwatered the bottom level has become practically dry, which points to the fissure connection of the various workings.

The ore here, like that at the south end, consists of blue and green carbonates with oxide of iron and earthy matter above the water level, whilst upon the top of the sulphide masses were rich cuprites with crystals of malachite and native copper, also silver, either in the form of chlorides or more frequently as thin metallic flakes, upon the faces of cracks or in cavities, whilst cobalt in the form of asbolite has also been met with in small quantities.

This portion of the vein carries a jasper vein upon the hanging wall which has been greatly crushed and brecciated in places, this is particularly marked below the water level, where the whole mass has been re-cemented with silica, after the deposition of a considerable quantity of metallic copper in it. A certain amount of oxidation has taken place near the rich pipe of ore in these workings below the water level, as is indicated by a large mass of ferruginous gossan and traces of carbonates even at the bottom level.

A new main shaft is now being sunk to the eastward of the magazine shaft with the ulterior object of, after cutting the lode, connecting all the existing groups of workings, in which process it is highly probable that other enriched zones will be met with, particularly if the lode is driven on at a depth of about 150 feet (zone of greatest enrichment), with frequent crosscuts, since there are over 300 feet both north and south of virgin ground to be explored before these connections are effected.

The country rock is greenstone, but it has been highly altered within a considerable radius of the lode owing to the perculation of acid solutions, whilst at other points it has been crushed, foliated and indurated until it presents characters very similar to slate.

This ore body is of very great interest, but will be of far greater when developments have extended downwards into the primary sulphide zone, since at present only those of weathering and enrichment can be studied, and in consequence any opinion formed of the former can only be conjecture based upon the behaviour of similar ore bodies in other countries.

The zone of weathering in this mine is most clearly defined, it embraces that section of the lode which lies between the surface and the level of the ground waters, or roughly the upper 100 feet. In this zone, as before stated, copper only occurs as carbonates, and iron as oxides, whilst the downwards leaching action of meteoric waters has practically removed all traces of copper from the surface, and considerably reduced the values of the rich bunch of ore in this zone, which were originally derived from the weathering of sulphide bodies similar to those met with in the zone below.

Below the zone of weathering lies the zone of secondary sulphide enrichment, which corresponds roughly with the zone of saturation. In this zone the ore occurs for the most part in irregular masses as copper glance associated with iron pyrites, the apex of such masses being invariably much richer than the lower portion. Upon this apex or at the point of contact of the two zones, ores of a transition character are met with, such as cuprite and native copper, whilst at one point, viz., in the middle workings, an open fissure lined with chalcedony is observable between the two zones, which allowed of the circulation of the ground water prior to the unwatering of the mine.

In the northern workings the brecciated jasper containing native copper points to secondary fissuring, and since this metallic copper is here met with considerably below its usual horizon in the lode, it may be assumed that this dislocation is of comparatively modern date, and further the circulation of the ground waters appears to have attained a maximum downward movement at this point, since we find oxides of iron (ferruginous gossan) contiguous with the rich sulphide ores and traces of carbonates down to the 150 feet level.

At the present time no primary sulphides of copper are present in this mine, but the State Mining Engineer states that he has seen specimens of chalcopyrite with marcasite still unaltered, and enclosed in chalcocite, which clearly points to the conclusion that these bonanza enrichments of secondary sulphides result from the replacement of a considerable quantity of iron pyrites, and the reduction of the copper sulphides to a more basic form by descending solutions of sulphate of copper derived from the weathering and oxidation of sulphide ores taking place at the ground water level.

In the zone of primary sulphides the ore will in all probability consist of yellow copper ore and iron pyrites, whilst, to judge from the form of the ore bodies met with in the upper zones, they will probably occur in lenticular bunches of considerable size and value contained in a large lean ore body.

There can be little doubt but that one main ore channel crosses these leases, which has now been opened at three points, proving its longitudinal extent to be not less than 1,300 feet, and when it is borne in mind that the aggregate distance driven above the water level is 620 feet and under it 500 feet between the 100 and 200 feet levels, and only 290 feet at the 300 feet level, it follows that in the large unprospected lengths of lode between the various workings, ore bodies of considerable size and value may exist, therefore, outside the existing rich deposits and the large body of low grade ore in sight, this property has very considerable prospective ossibilities.

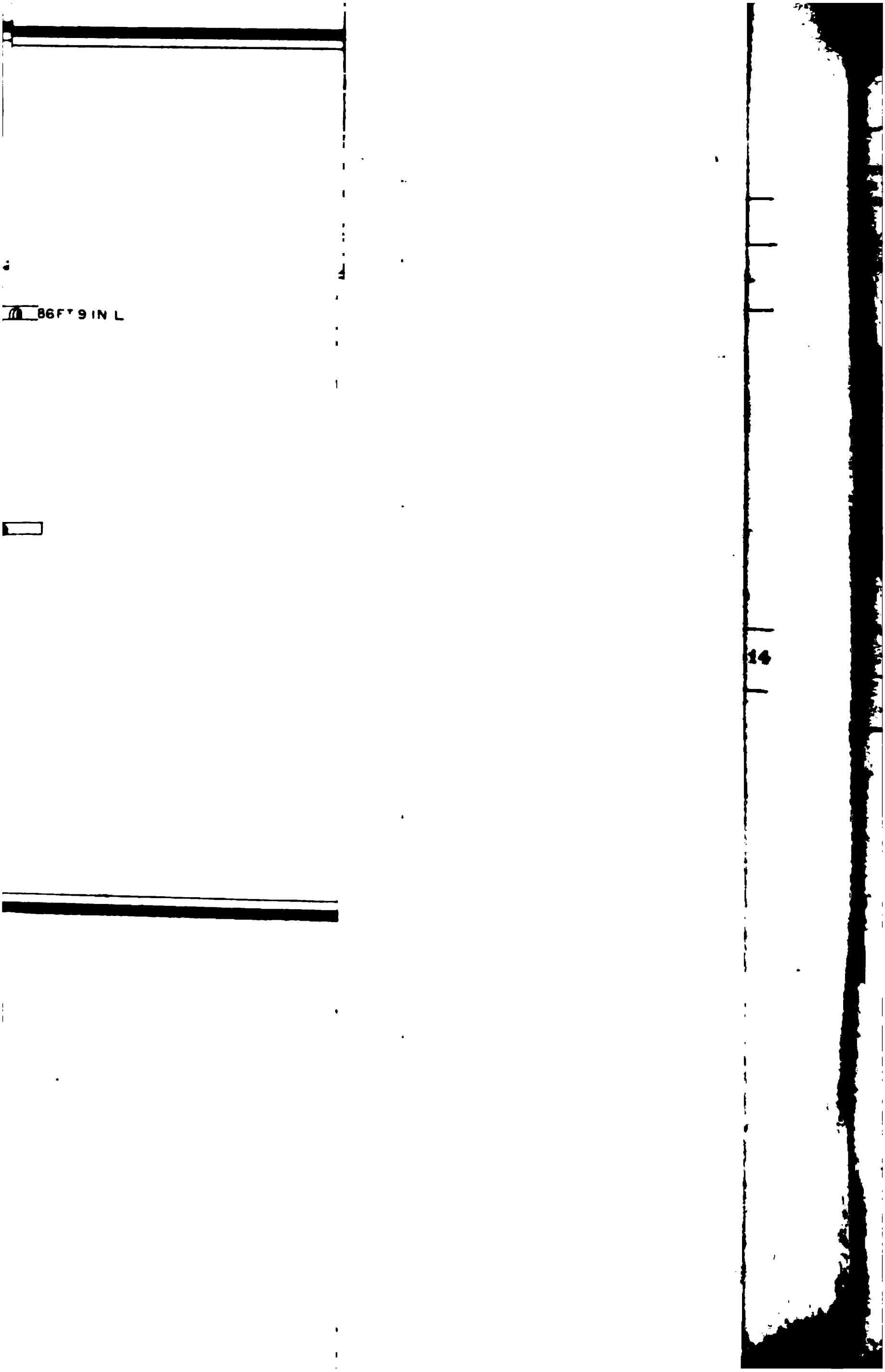
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Table shewing the Yield of the Mt. Malcolm Copper Mine to the end of 1907.

Year.	Name and Number of Lease.	Ore Raised	Copper Contents	Value per Ton	Total.		
					Ore Raised	Copper therefrom	Value.
		Tons.	Per Cent.	£	tons	tons	£
1899 ...	Mt. Malcolm Copper Mine M.L. 10C	22·00	16·6	10·5			
1900 ...	do.	3,950·00	7·7	6·1			
1901 ...	do.	7,590·00	7·5	5·3	11,563·00	877·47	63,902
1902 ...	Mt. Malcolm & Murrin Copper Mines Ltd M.L. 10C	1,954·00	6·4	3·5	1,954·00	124·50	6,852
1903 ...	Murrin Copper Mines Ltd. M.L.'s 6C, 10C etc.	18,965.00	4·2	2·4			
1904 ...	do. M.L.s (6C), 10C etc	500·00	4·0	1·8			
1905 ...	do. M.L.'s (6C), 4F, (10C), 5F (11C)	—	—	—	19,465·00	810·50	46,457
1906 ...	Mt. Malcolm Copper Mine M.L.'s 4F, 5F	3,839·00	10·8	4·4	3,839·00	418·00	17,065
1906 ..	West Australian Copper Co., Ltd., M.L.'s 4F, 5F	400·00	33·0	8·75			
1907 ...	do.	4,996·75	23·5	11·3	5,396·75	1,310·70	60,138
	Total	...	...	...	42,217·75	3,541·17	£194,414

PART III.

A Report upon Fraser's Gold Mine, Southern Cross, Yilgarn Goldfield.

INTRODUCTION.

About the middle of 1907, the British and Foreign Development Syndicate, Limited, who own this group of mines, approached the Government with the object of obtaining a State subsidy for deep boring. Before recommending this the Hon. Minister instructed the present writer to proceed at once to the mine and to make a thorough examination upon the spot, the following being the report submitted :—

THE BRITISH & FOREIGN DEVELOPMENT SYNDICATE, LTD. G.M.L.'s 13, 29, 279, 505, 506.

This property, which embraces the old Central, Fraser's and Fraser's South mines, is situated at Southern Cross, which is upon the Eastern Railway Line at a distance of 236 miles from Perth.

These mines were discovered in the year 1888, and are the oldest working to-day upon the Eastern Goldfields of Western Australia, but, owing to the low grade of the ore they were passed over when the great influx of capital set in, otherwise there is little doubt that they would occupy a very different position to what they do to-day.

Fraser's reef, or to be more correct ore channel, strikes in a north-westerly and south-easterly direction with a dip of from 60 to 70 degrees to the westward, ie is a large body of the composite order confined between two well defined walls, which give evidence in places of considerable crushing and grinding action.

This lode, or ore channel, which has proved to be auriferous for a length of one mile, will average something like 20 feet in thickness, being composed of a number of veins, strings and bunches of quartz, intermixed with a considerable quantity of schistose rock, the whole being enclosed in schistose amphibolite country.

The main ore channel is accompanied by two other ore bodies, which lie parallel to it upon either side, but neither of which outcrop, these are called Sholl's and

Hogg's reefs respectively, the former lies to the east and is very similar in character to Fraser's reef, whilst Hogg's, which lies to the west, is entirely different, being more ferruginous and having ragged walls.

The whole of this auriferous belt is enclosed between a barren quartz reef upon the east (called the Battery Reef), which can be traced for a distance of two miles, and a series of hematite bearing quartzite veins upon the west, whilst about 20 chains farther to the eastward, the granite outcrops, its contact with the amphibolite having a course parallel to the lodes, which therefore may be classed as parallel contacts.

The main line of lode can be easily traced at the surface from the edge of the lake northward through Fraser's South, Fraser's, Central and the old Central Extended without apparently a break, but after crossing the lake at the south end the reef there met with is found to be considerably off the general course, which is probably due to a fault.

In the mine itself another well defined fault has been encountered in the lower levels, which cuts the reef obliquely upon a course a little west of north-west, but apparently little dislocation has taken place, since the lode was worked without a break in the upper levels.

In the lower levels no attempt appears to have been made to locate the position of the lode upon the other side of the slide, for when this was encountered it was followed instead of being crosscut.

It is not unusual to find some 9 inches or 1 foot of barren white quartz upon this fault plane at the point where it intersects the lode, and at such places it demonstrates clearly that the faulting was secondary to the formation of the ore body, since all the quartz layers are cut diagonally, and come in contact obliquely with the solid barren vein. *

It will be needless to enter into a description of the extent of work done upon these mines, as this report is accompanied by a plan, a longitudinal and a series of cross sections (Plate IV.), which will make it far clearer than if given in writing, the only point upon which emphasis need be laid is that the lode is as well defined in the bottom levels as in the ones above.

These plans show the assay values obtained by hand sampling, but, owing to the peculiar character of the lode,

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* See also Bulletin No. 17, p.p. 24-27. Perth. By Authority, 1904.

and its great variability in value, these cannot be entirely depended upon. This has been clearly demonstrated in that a bulk sample of 71 tons taken in equal quantities from 14 shoots above the No. 5 level is reported to have yielded gold at the rate of 18/6 over the plates and 14/4 by cyanide, making a total of 32/10 per ton of ore treated, whilst during the year 1902, 14.541 tons of ore were crushed, the bulk of which, reported to have been taken mostly from the same stope, yielded gold at the rate of 18/7½ by battery and 12/6 by cyanide, or a total of 31/1½. If this is compared with the assay value of the same stope obtained by hand sampling, a very considerable discrepancy will be noted, but this is in part accounted for by the fact that the stone is picked to a certain extent in the stopes on account of the schists being practically barren and the mill capacity small, therefore about 30 per cent. of the ore is discarded, which, if added to that milled, reduces its value as a whole to 21/-.

From the year 1890 up to the end of 1906, these mines have yielded a total of 152,597.78 ounces of fine gold from 204,854 tons of stone, which averages .53 ounces per ton.

The attached table gives the annual production of each mine so long as it was worked by itself, and under one head when worked together. From this it will be seen that the results are in some cases very variable, this is not due to sudden increases in value, but to the inclusion of the result of the treatment of accumulated sands by cyanide, thus in 1900-1 we find that the Central mine suddenly springs from .36 to 2.54 ounces to the ton. Upon Fraser's and Fraser's South mines the sands do not appear to have been treated until these properties were taken over by the Mines Development Syndicate in 1901, and in consequence this company's returns varied from year to year according to the proportion of stone crushed to the sands treated, during the last year, however, the accumulated tailings had been practically all handled, thus reducing the average value of the stone crushed to .52 ounces per ton, which is only .01 below the average value of the ore treated since these mines started, thus proving conclusively the great consistency of the lode values. It is true, of course, that near the surface richer ore was obtained, but since a considerable quantity of the resulting tailings were used for filling (some of which are now being raised by tributers), the average value of the lode has not been unduly inflated.

From a geological point of view there is every probability of this lode, which is a true fissure continuing downwards, whilst there is absolutely no reason why the values should not do likewise, since so little change has taken place in them so far.

It is probable that the fissures called Hogg's and Sholl's reefs will junction with the main body at no great depth, in which case it is highly probable that a zone of considerably increased values will be met with. It would appear also from the cross-sections that the main barren Battery lode is approaching the Fraser's lode in the lower levels, should this unite, although barren, it will in all probability also cause enrichment.

To the westward of the ore channel are a series of hematite bearing quartzite veins, similar ones to which in the Murchison district have exercised very considerable influence upon the quartz veins with which they come in contact, causing phenomenal richness, whilst these mineral bearing quartzites, although barren at the surface, may possibly prove to be auriferous at a depth.

The only means of solving this important problem cheaply is by putting down a series of bore holes in a systematic manner; one or two bore holes without method would be worse than useless, since no reliance could be placed upon the results, neither would they be conclusive.

This boring should consist of 10 or 12 holes to alternate depths of 750 and 1,000 feet, they should not be farther apart than 100 feet, and should be so planned as to cut the entire thickness of the formation.

From a mining engineer's point of view this lode can be worked more cheaply than any in W.A., for not only are the wages lower, but there is an abundance of fine timber for mining purposes and fuel close at hand, an abundant supply of salt water can be obtained from below the lake, and a main connects the mine with the Goldfields Water Supply, whilst further, there are about 140 miles less railage to pay upon stores and machinery than to Kalgoorlie.

It is a large low grade mine, which would have paid well had the capital been forthcoming to develop and equip it in a proper manner, but with an old fashioned battery of 30 head, having an outside efficiency of two tons per stamp in 24 hours, economic working is out of the question.

The stone treated from this mine to date has upon the average been worth 45/- per ton; this has been more or less picked, but it has paid well from its inception, even in the crude manner in which it was worked.

The mine is now rapidly coming to an end of its ore reserves, not that there is not a considerable quantity of low grade ore in it, but, owing to the fact that only the highest values will pay under the present system of working, whilst capital is not available for further prospecting or development. Tributers are already working in the upper levels, but so far have not been allowed in the lower, but so soon as this takes place the end of this mine will not be far distant.

Only one thing can save this mine, that is the establishment of the fact that the lode carries payable values at a greater depth, but, not having sufficient capital to undertake this themselves, the company are applying for Government assistance to bore. Should this boring be successful there is little doubt but that this mine would commence a new lease of life under better conditions than previously.

Since this is a question of vital importance, not only to this mine or district, but to the State as a whole, this request should be considered, for, should the fact be once established that these large low grade bodies carry payable ore at a depth, there is not the least doubt but that a number of others of the same class will also be tested.

This lode is especially suitable for this experiment for, firstly, its great size and length and the character of its walls, point to the conclusion of permanency in depth; secondly, the general dissemination of the gold through the lode body for so great a length without the marked occurrence of shoots or lenticular bunches affords great encouragement with regard to its continuation to carry values to a depth; thirdly, the enclosure of a well defined ore channel between a white barren reef of considerable extent upon the one side and the ferruginous quartzite veins upon the other, also support the theory of permanency; fourthly and lastly, this lode lying in a contact zone parallel to and dipping from the intruded granite, which lies at a short distance to the eastward, is also favourable both to permanency and the continuity of values.

The only conclusion that can be drawn is that if boring is undertaken here conjointly by the Government and the Company it will be with every probable prospect of success.

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Table shewing the Yield of the Frasers' Reef.

Year.	Name and No. on Lease.	Ore Crushed	Gold therefrom.	Rate Per Ton	TOTAL.		Average Rate per ton.
					Ore Crushed	Gold Therefrom	
		Tons	ozs.	ozs.	Tons.	ozs.	ozs.
r to 1897	The Central Mine G.M.L. 279 ...	37,482·00	14 154·45	·37			
1897	do. do. ...	3.934·00	792·67	·20			
1898	do. do. ...	895·00	513·36	·57			
1899	do. do ...	1,208·00	459·19	·38			
1900	do. do. ...	1,086·00	2,550·70	2·34			
1901	do. do. ...	403·00	1,232·48	3·05	44,958·00	19,702·85	·44
r to 1897	Frasers' South Mine G.M.L. 29 ...	39,478·00	16,338·71	·41			
1897	do. do. ...	8,755·00	3,674·52	·42	48,233·00	20,013·23	·4
r to 1897	Frasers' Mine G.M.L. 13 ...	58,123·00	31,533·19	·54			
	do. do. ...	20,552·00	8,711·41	·42			
1897	do. G.M.Ls 13, 29 ...	22,900·00	7.794·94	·34			
1898	do. do. ...	23,870·00	7,702·92	·32			
1899	do. do. ...	24,703·00	10,577·07	·42			
1900	do. do. ...	1,623·00	1.550·80	·95	151,771·00	67,870·33	·44
1901	British & Foreign Development						
1901	Synd.. Ltd. G.M.Ls. 13, 29, 279, 505, 506 ...	22,136·00	14,852·03	·67			
1902	do. do. ...	14,712·00	11,474·48	·76			
1903	do. do. ...	1,759·50	3,543·18	2·01			
1904	do. do. ...	5,160·00	5,836·88	1·13			
1905	do. do. ...	8,603·00	5,343·61	·61			
1906	do. do. ...	7,521·50	3,961·19	·52			
1907	do. do. ...	7,579·75	4.649·53	·61			
					67,471.75	49,660· 0	·73
	Total	...	...	...	312,433·75	157,247·31	·50

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GOVERNMENT ASSAYS.

ASSAYS, Analyses, and Determinations of any Western Australian Ore or Rock will be made by the Assayer to the Geological Survey, *when not unduly interfering with official work*, subject to the following conditions :—

1. Each sample must weigh at least 6oz., but not more than 2lbs.
2. Each sample must be enclosed in a separate canvas bag or strong paper wrapper, with a slip of paper bearing the name and address of the sender, together with a private mark by which it may be readily identified.
3. The parcel must be forwarded, *prepaid*, to :—

The Government Geologist,
Geological Survey Office,
Perth.

4. A letter must be sent at the same time to the same address, stating for what metals the samples are to be assayed, or containing other instructions, as the case may be.

(N.B.—It is always advisable to keep duplicate samples of those submitted.)

5. Before any assay is made the prescribed fee must be paid to the Mineralogist and Assayer, or sufficient reasons, in accordance with Section 7 below, be furnished for having the samples treated free of cost.

6. The following fees will be charged :—

		£	s.	d.
(*a.*)	Determination of a Rock or Mineral	0	10	6
(*b.*)	Assay for Lead, Iron, or Manganese, and Phosphoric Oxide, each	0	10	6
(*c.*)	Assay for Silver, Copper, or Tin, each	0	12	6
(*d.*)	Assay for Gold or Zinc, each	0	15	0
(*e.*)	Fire Assay for Lead, Silver, and Gold	1	1	0
(*f.*)	Assay for Antimony, Bismuth, Chromium, Cobalt, Mercury, or Nickel, each	1	11	6
(*g.*)	Proximate Analysis and Calorific Valuation of Coal	1	11	6
(*h.*)	Complete Chemical Analysis of any Mineral or Ore, according to number and nature of determinations ... £2 12s. 6d. to	5	5	0
(*i.*)	Other determinations, according to time spent, up to	2	12	6

A reduction of 20 per cent. on the above amounts will be made in favour of any person submitting, in one parcel, five or more samples for identical treatment.

7. With the object of encouraging *bonâ fide* prospecting, free Assays will be made under the following circumstances :—

(*a.*) The sample must have been obtained from land within the State not held under lease for mining purposes.

(*b.*) The exact locality where the sample was found must be disclosed.

(*c.*) The sample must be of sufficient promise to warrant an assay being made at the expense of the State.

(*d.*) Free Assays will not be made of samples showing free gold, or of tailings or other metallurgical products, or of umpire samples.

8. The Department reserves to itself the right of refusing to make any particular Assay, and also the right of publishing at any time the results of an Assay made at the public expense.

A. GIBB MAITLAND,
Government Geologist.

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